the OIL AND GAS JOURNAL

APRIL 16, 1956

Annual

FIELD PROCESSING Number

- Instrumentation in '56
- Markets—a time for decision
- Role of electronic computers
- Processing plant survey

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Should California Adopt a Conservation Law?

YES... Says Richfield's Ragland | NO... Says Union's Rubel

p. 122

Reduce Down-Time Costs

with ROCKWELL-Nordstrom VALVES

The two most common valve problems that cause excessive down-time costs are seat failure (leakage) and wear. Performance records in thousands of refineries and gasoline plants prove that Rockwell-Nordstrom valves cut down-time costs because they *stay leakproof* and *wear longer in service* than any other valve. In Rockwell-Nordstrom valves, there are no exposed seats to be cut-out or corroded. Leakproof, positive shut-off is assured by pressurized lubricant sealing. Lubricant also eliminates the metal-to-metal friction that causes ordinary valves to wear out so quickly.

The low maintenance cost and dependability of Rockwell-Nordstrom valves is a matter of record, yet they cost no more to buy, often less, than ordinary valves. Available in a complete range of sizes and pressure ratings. Write today for more information: Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Canadian Valve Licensee: Peacock Brothers Ltd.

ROCKWELL-Nordstrom **VALVES**

Lubricant Sealed for Positive Shut-Off
40th YEAR *of lubricated plug valve leadership*

A Glance Ahead . . . . at press time

These trends will make TOMORROW'S NEWS

A retractable drilling bit which can be changed without a round trip has been developed by the research department of a major oil company.

The bit is used on large-diameter drill casing. It is lowered on a wire line and, when positioned, opens into drilling size. When the bit is dulled, it is disengaged, "folds" to a smaller diameter, and is withdrawn through the drill casing.

The bit has a long shank, and a sinker bar resting on this adds weight to the bit. Additional weight is provided by use of extra-heavy casing at the bottom of the drill string. The bit has been made in both 3-cone and 4-cone models.

Purpose of the design is to cut drilling time in deep holes by reducing the number of round trips required. The bit, not yet in manufacture, is expected to be licensed shortly.

Look for increasing emphasis on precise fractionation of light ends in both refineries and natural-gasoline plants. Splitting isomers and segregating other pure hydrocarbons will provide the stocks which will be needed more and more for future octane-improvement processes and petrochemical operations. Superfractionation is going to get important.

Transcontinental Pipe Line plans to do more internal coating of big-inch pipe, in spite of the fact it hasn't fully decided yet how effective was the work done last year. If FPC approves a pending construction program, Transcontinental will coat internally 59 miles of 30-in. and 72 miles of 36-in. out of a total of 228 miles it plans to lay. Coating would be done at mills of Republic Steel and Bethlehem.

Refiners may find that butane will be used for a long time in blending for volatility. More emphasis is going to be placed on pentane isomerization for octane improvement, but refiners are warned that there is a limit to the use of even high-octane isopentane, since it can develop vapor-lock problems if used in overdoses.

Keep an eye on turnkey drilling contracts. Some contractors report a pickup in this type of business recently, although still admittedly only a fraction of their total.

Many contractors are set up for the turnkey service. They can control a well from spudding to completion, call the shots on mud, casing, hole deviation, subcontract the geology, well servicing, and tankage, and turn the well over to the operator when crude is run into tanks.

They attribute the pickup to more small operators getting lease farmouts from the majors, to promoters wanting a turnkey bid to guide them in rounding up financing, and to deals where the driller takes a piece of the lease.

Operators with small staffs think the way of doing business may be cheaper for them in the long run.

Gas pipeline firms are looking at the prospect of combining scatter microwave systems with automatic booster stations. Scatter systems would cover 70 to 90 miles in a hop. They would have terminals at compressor stations only and have no remote microwave repeaters. One such system is now planned, but whether it is built depends on (1) FPC approval and (2) a drop in the price of scatter equipment.

the OIL AND GAS JOURNAL

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SPECIAL FIELD PROCESSING SECTION

Natural-Gasoline and Cycling-Plant Instrumentation **140**

By E. E. Kleir

As field processing operations have become more complex, methods of controlling them have kept pace. Here is a 10-part discussion on new instrumentation developments.

Cities Service Ambrose Gasoline Plant **150**

By John C. Reidel

This plant, located in Kay County, Oklahoma, uses perforated trays to get increased capacity. It operates on a lean-gas stream and has a two-still system.

A Time for Decision in Field Processing **153**

By George Weber

Field processors must fractionate and convert their raw products to realize greatest potential returns—or defer to others and share future profits.

Vapor-Velocity Effects on Bottom Entry Trays **158**

By E. G. Ragatz and W. A. Baxter

Entering jet velocities play little or no part in establishment of column tray efficiencies in high-capacity columns. The dominating efficiency factor is turbulence.

Electronic Computers Can Help **162**

By Dr. Elliott I. Organick

Electronic computers are revolutionizing certain aspects of process engineering in the natural-gasoline industry.

Natural Gasoliners Like Robot Calculators **164**

By J. R. Cobb and R. L. McIntire

Phillips Petroleum Co. uses a medium-size magnetic-drum electronic computer in its mathematical engineering group, research and development department.

Operating Problems Yield to Electronic Brain **168**

By J. C. Schneider and R. G. Wright

Shell Oil's Midland area uses a card-programed electronic computer for solving technical operating problems. The gas department has solved several problems.

Annual Survey of Field Processing Plants **172**

By LaWanda Turner

Total production of all natural gasoline and liquefied petroleum gas in the United States during 1955 rose 6.3 per cent over 1954.

Construction Tables, Field Processing Plants **187**

How Management Decides to Build **191**

Here is a four-article symposium on this important subject.

Analyzing Hydrocarbon Mixtures **211**

By W. J. Podbielniak and S. T. Preston

Conventional low-temperature distillation equipment has been improved and vapor-phase chromatographic equipment is now available for hydrocarbon analysis.

Cathodic Protection Stops Corrosion **220**

By M. J. Olive

Arkansas Fuel Oil is successfully mitigating corrosion on the water side of equipment in its East Texas plant by combining cathodic protection with water treatment.

A Plant-Wide Corrosion-Control Program **228**

By O. L. Gambrell

This article outlines a three-point program which will enable the operator to maintain his plant economically and safely.

Sunray's Red Fish Bay Gasoline Plant **244**

By Ben Lovell and Larry Resen

An extensive offshore gathering system features this new plant near Corpus Christi.

Technology—Operation

Here Is the Latest on Jet-Bit Drilling **251**

This technique has had a tremendous effect in cutting drilling costs in the last 3 years.

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WITH THE

"ZC"

You can mount a Fairbanks-Morse "ZC" engine on your pumping jack the way you want it. Clutch and sheave can be mounted on either side of the engine *without sacrifice in efficiency, smoothness or balance.* With the famous Fairbanks-Morse extra-heavy, large double flywheels, there is always one flywheel between engine and load. You get perfect balance, poised or rolling . . . smoother, more efficient, more economical operation.

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Now...can be your *best* time to cure next winter's heating oil headaches

Some of your next winter's supply of home heating oil may be in your refinery processing run right now.

But how can you be sure it will come out of storage as stable as it goes in? Will *your* distributors be making unprofitable service calls to clean gummed-up ignition systems or replace sludge-clogged filter screens or nozzles?

You can answer these questions *now!* . . . Desired storage stability can be easily obtained by adding Du Pont Fuel Oil Additive No. 2 (FOA-2) to your freshly prepared stocks at the refinery—*before they go into storage.*

Ashless

Many distributors' service calls may be caused by electrical failures due to a metallic ash coating on the electrodes and stack controls. Because it is *ashless,* Du Pont FOA-2 does not contribute to these wasteful calls.

Filter-clogging can be greatly reduced by the addition of FOA-2 because it not only stabilizes the fuel, but also disperses any sludge that may already be formed—by reducing the size of the sludge particles.

Avoid gel-clogged lines

By adding a small amount of Du Pont Metal Deactivator, too, you can protect your heating oil from becoming contaminated by the copper so frequently used in home heating system screens and fuel lines. This protection will, in most cases, eliminate any danger of the fuel lines becoming clogged by a gelatinous material, caused by copper pickup in the line.

Low-cost insurance

You can add both DMD and FOA-2 in amounts sufficient to give your stocks adequate protection all the way through next winter's heating season for only about 1.5¢ per barrel. And you'll find that it more than pays for itself in insurance against future troubles.

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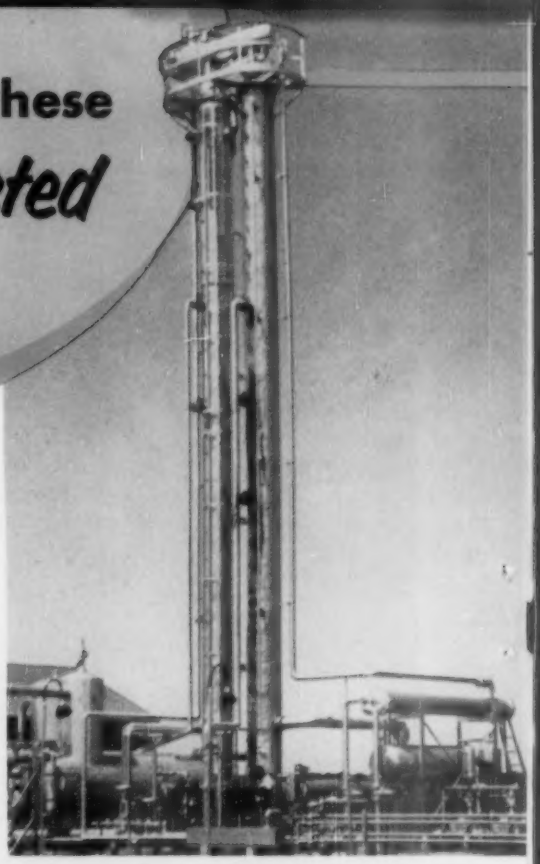
They're stripping gasoline from gas with these "Oilwell" Direct-Connected Compressor Units



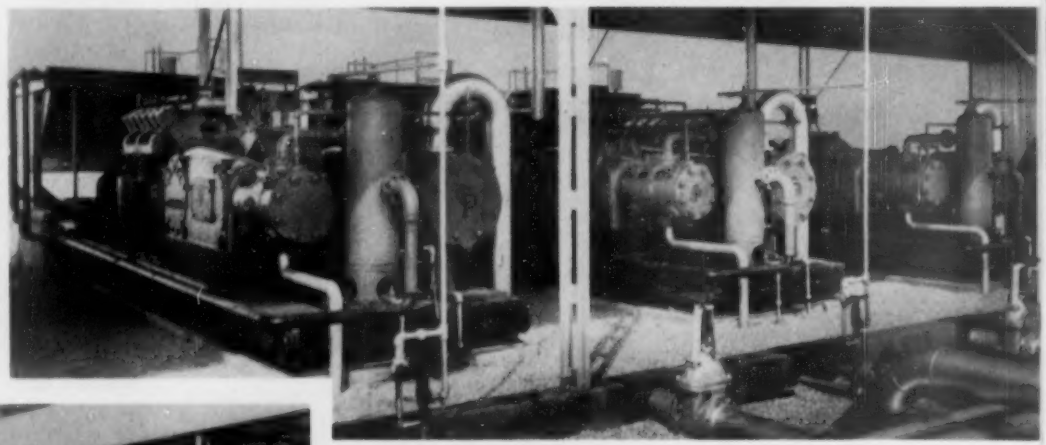
IN this modern gasoline and LPG plant near Norman, Oklahoma, some 3,550,000 cubic feet of gas per day is stripped of condensate and liquid petroleum products.

Three "Oilwell" DGE-250 two-stage compressor units take wet gas from separators at 5 psi and boost it to 445 psi for processing through the plant.

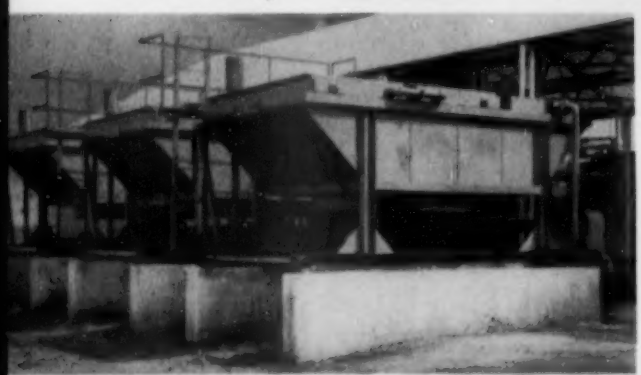
On each unit, the direct drive from prime mover, through right-angle gearing, to two parallel compressors, utilizes the input horsepower with maximum efficiency. V-belts and clutches are eliminated by this arrangement.

Units of this type are available in 125, 175, 200, 250 and 300-hp sizes. On all but the two larger sizes, up-draft radiators are mounted above the compressor gear box and supported directly from the skid base.

This bank of three direct-connected units are tied into a common header system, permitting flexibility of operation.



Heavy-duty, horizontal, up-draft radiators have divided cores for separately cooling engine and compressor. Circulating pumps and cooling fans are driven from the engine crankshaft by means of a torque tube and fluid coupling.



FOR COMPLETE INFORMATION . . . and any assistance desired in analyzing your requirements, contact your nearest "Oilwell" Representative. Field engineers are always available. No obligation.

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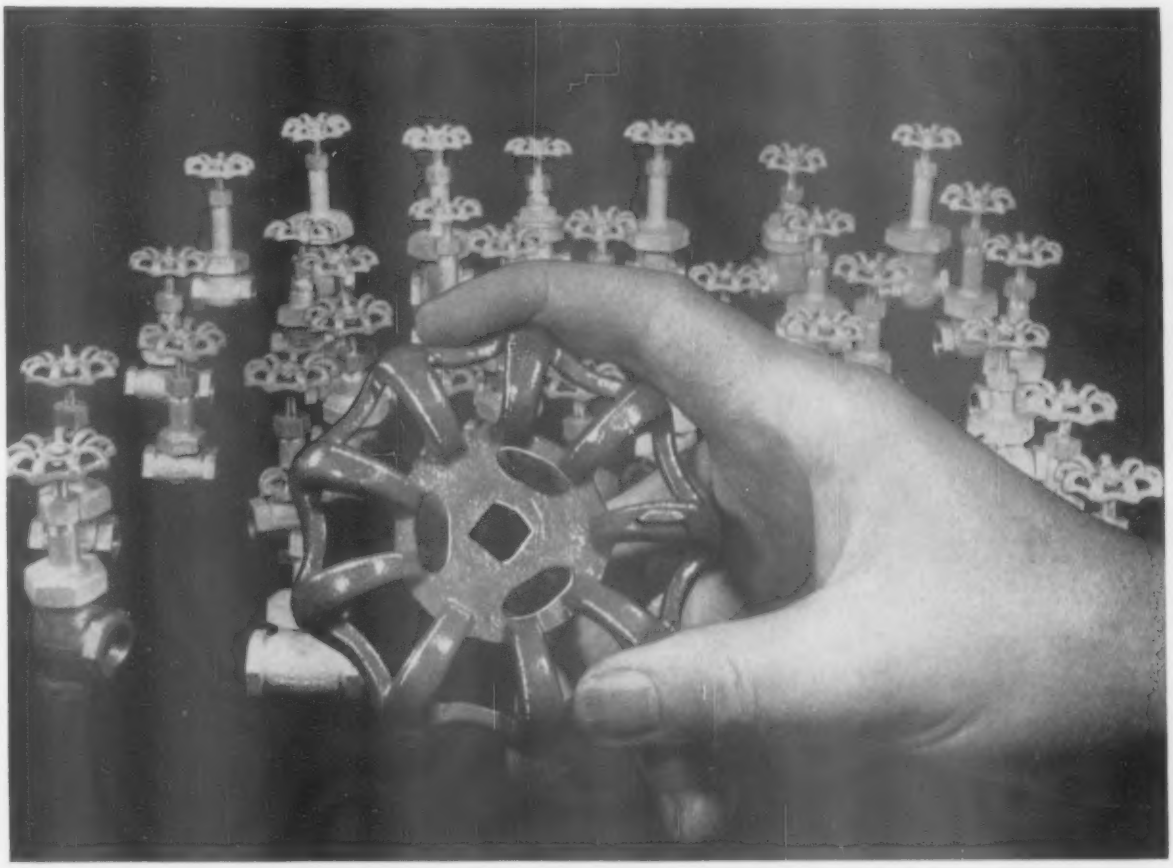

One handwheel fits 39* different valves

*Walworth Handwheel No. 16 fits these Walworth Bronze Valves:	
¾"	No. 32, 40, 47, 48, 205, 206, 225P, 227P, 260, 261, 260P, 261P
1"	No. 29, 30, 36, 37, 91, OX91, 92, 95, 96, 160, 161, 235, 236, 245, 246, 245P, 246P, 237P, 238P
1¼"	No. 58, 59
1½"	No. 2, 3, 4, 11, 12, 14

Only Walworth Bronze Valves give you this degree of interchangeability

With standardized Walworth Bronze Valve parts you maintain the greatest number of valves with the smallest inventory of basic parts. Handwheels are just one example. Fourteen different sizes of handwheels are all you need for fifty lines of gate, globe, and angle valves, involving 420 individual valves.

The Walworth system of interchangeability of parts for Bronze Valves is unsurpassed by any manufacturer in the field. In addition to Bronze Valves, Walworth produces valves and pipe fittings of iron, steel, special alloys, and rigid polyvinyl chloride (PVC).

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GM GENERAL MOTORS

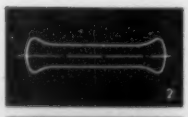
HYATT ROLLER BEARINGS

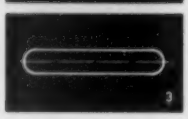
1. DISTRIBUTION OF LOAD WITHIN THE BEARING

Rollers are subjected to load only while in the "load zone," with maximum load while on the line of action of the bearing load, as shown in diagram 1. The theoretically perfect "load zone" extends from −90° to +90° from the line of action, but this is neither practical nor necessarily desirable. Under normal loadings, the actual "load zone" may range from 90° to 120°, depending on load and mounted internal clearance. This distributes the load so the load on the heaviest-loaded roller is approximately 5/N times the bearing load, where N is number of rollers.

2. DISTRIBUTION OF LOAD WITHIN ROLLER'S AREA OF CONTACT

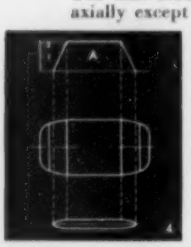
A cylinder deflects locally in the region of engagement when loaded between flat plates. The plate also deflects, so the original line of engagement is broadened into a "dog-boned" area under load, as shown in diagram 2. Moreover, deflected cylinders must gather in metal at their ends in *two planes, and this end-loading effect can seriously reduce the life of a cylindrical roller bearing.* All HYATT rollers have generous corner radii or blended chamfers to reduce end effect; and all HYATT Hy-Load rollers also have crowning to allow the contact area to "fade out" evenly (diagram 3).





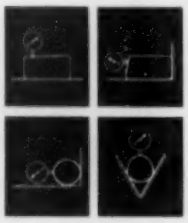
3. DISTRIBUTION OF LOAD ACROSS ROLLER

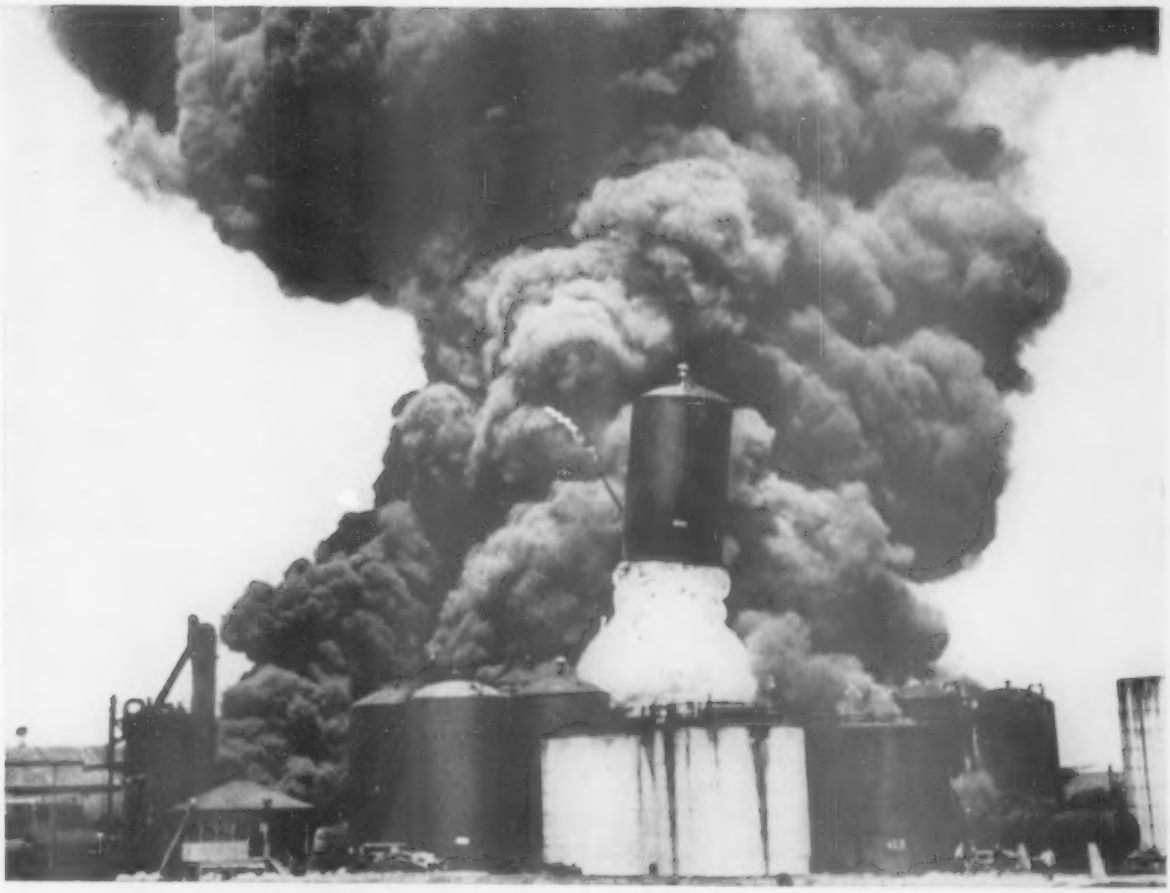
The unit load on any roller is uniformly distributed axially except at the crowned ends where it drops off to zero as shown in diagram 4. The summation of unit loads represented by area A is the total roller load. This same load under misalignment results in an area equal to area A; but maximum unit load is considerably greater and the bearing will have a shorter life than a properly aligned one. When the same total load is applied to an *uncrowned* roller, an even higher unit load results. This demonstrates the value of crowning when misalignment occurs.



4. EFFECT OF ROLLER QUALITY ON BEARING PERFORMANCE

Lack of roller quality control has a very adverse effect on performance: 1. A roller with excessive *taper* tends to uneven load distribution and abnormal temperature rise. 2. A roller with excessive *end square* tends to noisy bearing performance. 3. A roller with excessive *two-point out-of-round* tends to poor segregation and poor bearing life. 4. A roller with excessive *three-point out-of-round* tends to noisy bearing operation. 5. A roller with *poor finish* tends to wear on all operating surfaces and noisy operation. 6. A bearing with excessive *roller-to-roller diameter variation* tends to poor bearing life. 7. A bearing with excessive *roller-to-roller length variation* tends to poor thrust capacity, abnormal temperature rise.





$500,000 skyrocket!

An exploding 2000-barrel asphalt tank booms skyward, showering flaming asphalt on adjacent tanks, to devastate this storage area. Once fire has gained such headway, it becomes extremely difficult to control.

But there is a time when practically any fire can be controlled — and kept from turning into a disaster. That moment is at the very start — and the way to do it is with a Grinnell Fire Protection System.

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- **Emulsion and vapor dilution extinguishment** — Mulsifyre and ProtectoSpray systems
- **Water spray for cooling, insulation, and controlled burning** — ProtectoSpray systems
- **Air foam blanket** — ProtectoFoam systems
- **Carbon dioxide blanket** — C-O-Two systems
- **Dry chemical systems**

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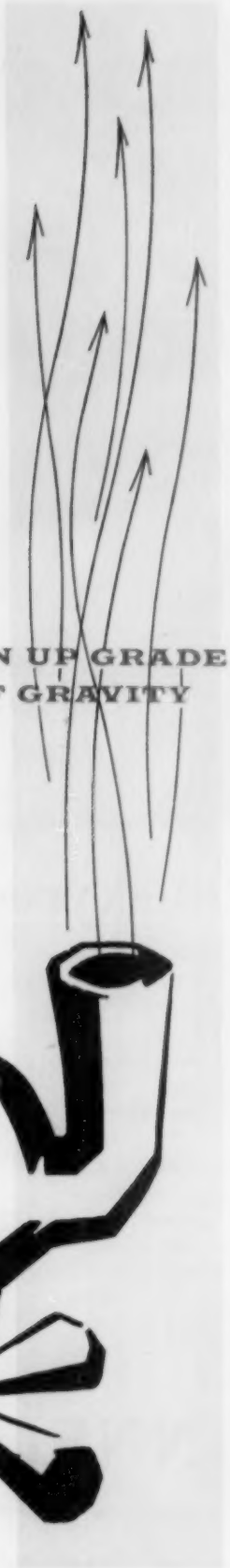
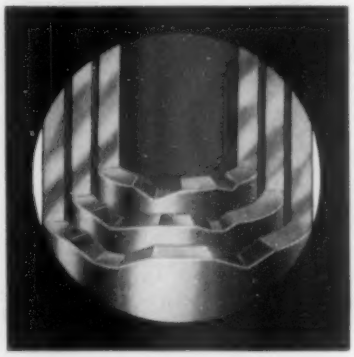


MAKING WATER RUN UP GRADE DEFIES THE LAW OF GRAVITY

Lifting water in the oil fields presents a like problem—whether it be a water supply well for a flood or just a plain wet oil well.

Fluid Packed Pump Co., in recognition of the Oil Industry's need for a Down Well Rod-Drawn Pump that will economically and efficiently handle large volumes of water, has applied the Multiple Tube Principle to its design of an over-size pump. The Multiple Tube Pump, by reason of its sleeve type construction, will maintain its maximum rate of efficiency in water, and does not require lubrication for successful operation.



The fluid packing between the tubes eliminates the need for lubrication.

The **OVERSIZE OILMASTER MULTIPLE TUBE PUMP** can be installed or removed on the rod string. The pump can be seated in a shoe on the bottom of large tubing or on a Packer Type, vertically setting Pump Anchor designed to set in the casing string.

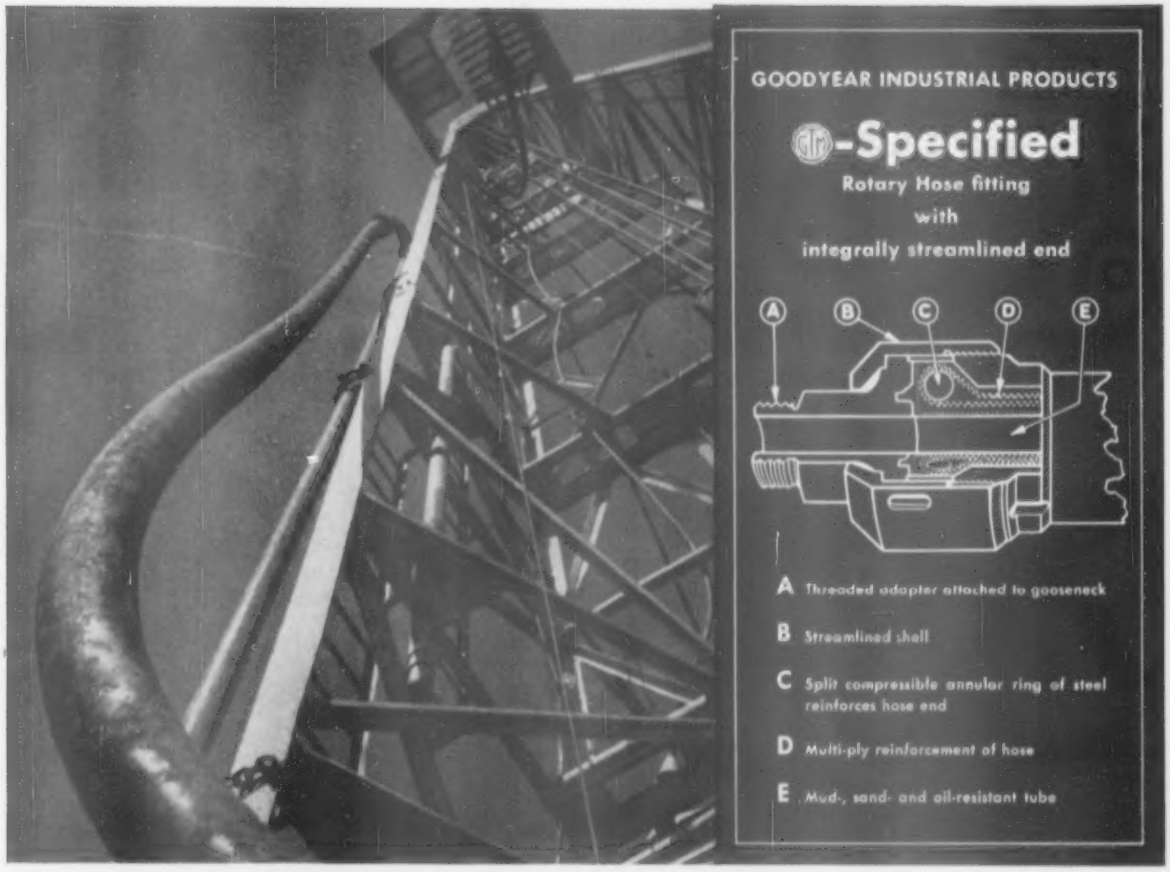
SPECIFICATIONS

Pump Bore	Pump O.D.	Tubing or Casing Size	Bore Factor*	Maximum Stroke
2¼"	2¾"	3" or larger	0.590	166"
2¼"	3¼"	4" or larger	0.881	166"
3¼"	3¾"	4" or larger	1.232	166"
3¾"	4"	5½" or larger	1.640	166"

*BORE FACTOR X STROKE LENGTH IN INCHES X STROKES PER MINUTE EQUALS BARRELS PER 24 HOURS.
EXAMPLE: 1.640 X 74" STROKE X 15 SPM—1,820 BARRELS.

Contact your nearest Fluid Packed Pump Co. representative or write for further details.

FLUID PACKED PUMP COMPANY
Main Office and Plant, Los Nietos, Calif.
Distributed by the National Supply Co., Pittsburgh, Pa. Export: The National Supply Co., Export Division, 600 Fifth Ave., New York • Co-Distributors: Berry Supply Store, Beacon Supply Co., Industrial Supply Co.



Drills over 200,000 feet

completing 36 wells

IN 1948, operators of one Southwestern drilling rig needed a new rotary hose. The hose just retired had drilled a total of 73,000 feet of hole. They felt they could do better. They called in the G.T.M.—Goodyear Technical Man.

The G.T.M. recommended Style 3153-H Rotary Drilling Hose with its exclusive, factory-built-in coupling. This hand-built, steel-wire-and-cable-reinforced hose is designed for drilling down to 15,000-20,000 feet where extreme bottom hole pressures are encountered. The streamlined coupling gives fast connections, full flexibility and maximum flow.

RESULT: Under the high pressures it encounters, this hose has drilled 200,000 feet of hole—36 wells in seven years. At last report it was still going strong, despite much handling and moving.

Full details on Style 3153-H are yours for the asking from the G.T.M., your Goodyear Distributor or Goodyear, Industrial Products Division, Akron 16, Ohio

ROTARY DRILLING HOSE and COUPLING by

GOODYEAR

THE GREATEST NAME IN RUBBER

We think you'll like THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network

Controlled Fissuring Power!

Welex BEAR GUN

(FORMATION FRACTURING TOOL)

The gun that shoots 'round a corner!

Welex called this mighty innovation the Formation Fracturing Tool when they developed and introduced it two years ago — you, in the field, gave it a new name after using it — the Bear Gun. By any name — oil operators everywhere are calling more and more for the tool's great fissuring power in their tough wells. Wherever the formation or a heavy invasion of mud or cement hinder the flow, call Welex for the Bear Gun. Each shot will give you a large entrance hole — deep into the formation — and the extensive fissuring that reduces pressures and makes your fracturing job a success!

Perforating is no sideline with WELEX!

ORIGINATORS OF JET PERFORATING

Welex JET SERVICES INC.

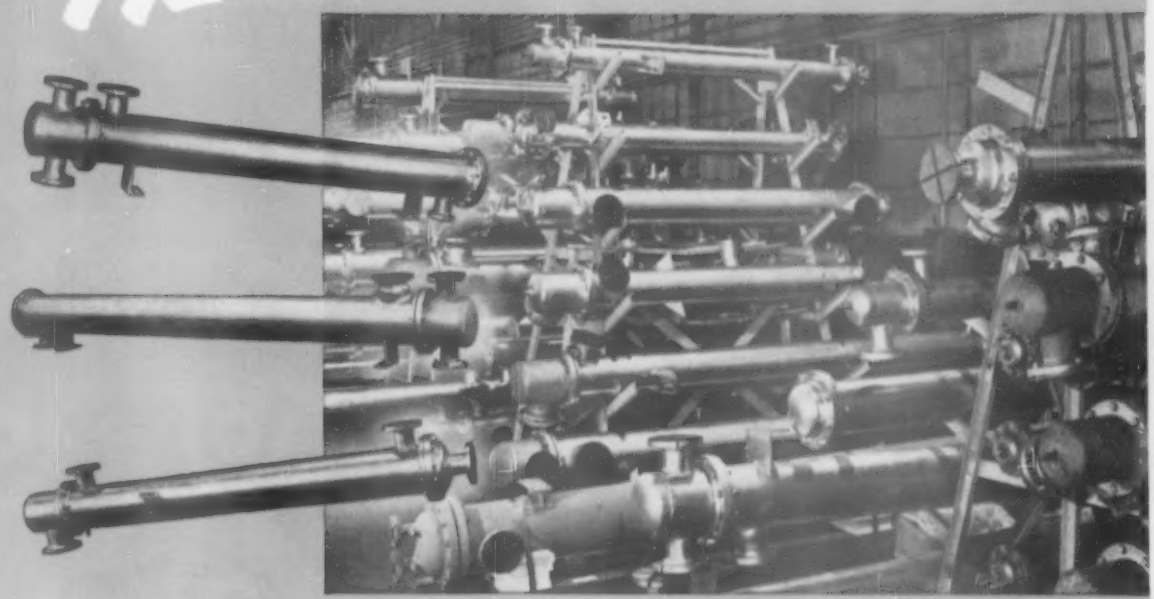
1400 E. Berry Street • Fort Worth, Texas

DIVISION OFFICES: Houston, Midland, Tulsa, Oklahoma City, Denver
SALES OFFICES: Dallas, Duncan, Wichita

DISTRICT OFFICES: Abilene, Ardmore, Bartlesville, Beaumont, Corpus Christi, Falfurrias, Farmington, Fort Morgan, Great Bend, Hobbs, Houston, Lafayette, Lake Charles, Liberal, Odessa, Pampa, Pauls Valley, Plainville, Pleasanton, San Angelo, Shawnee, Sherman, Snyder, Stillwater, Wichita Falls, Winfield.

Struthers Wells

Standard HEAT EXCHANGERS



Struthers Wells now offers a line of Standard heat exchangers—in sizes from 20 to 400 square feet of surface—including fixed tube sheet, floating head and U-tube units. Condensers, coolers, heaters and reboilers can be supplied in single and multipass tube arrangements.

Standard heat exchanger construction includes materials of carbon steel, non-ferrous alloy, and stainless alloys Type 304 and Type 316. Equipment meets highest construction standards, including ASME Code and TEMA Class A.

Typical units are illustrated above, including a partial view of those in stock, ready for immediate shipment. Standardization of design and quantity manufacture enables us to offer this equipment at very reasonable cost.

STRUTHERS WELLS PRODUCTS

PROCESSING EQUIPMENT DIVISION

Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

BOILER DIVISION

BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

FORGE DIVISION

Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

MACHINERY DIVISION

MACHINERY for Sheet and Structural Metal Forming . . . Tangent Benders . . . Folding Machines . . . Boiler Tubs and Tumble Die Bending Machines . . . Press Brakes . . . Punching and Notching Machines . . . Forming Dies

Any Size Available for Quick Delivery!

STRUTHERS WELLS *Corporation*

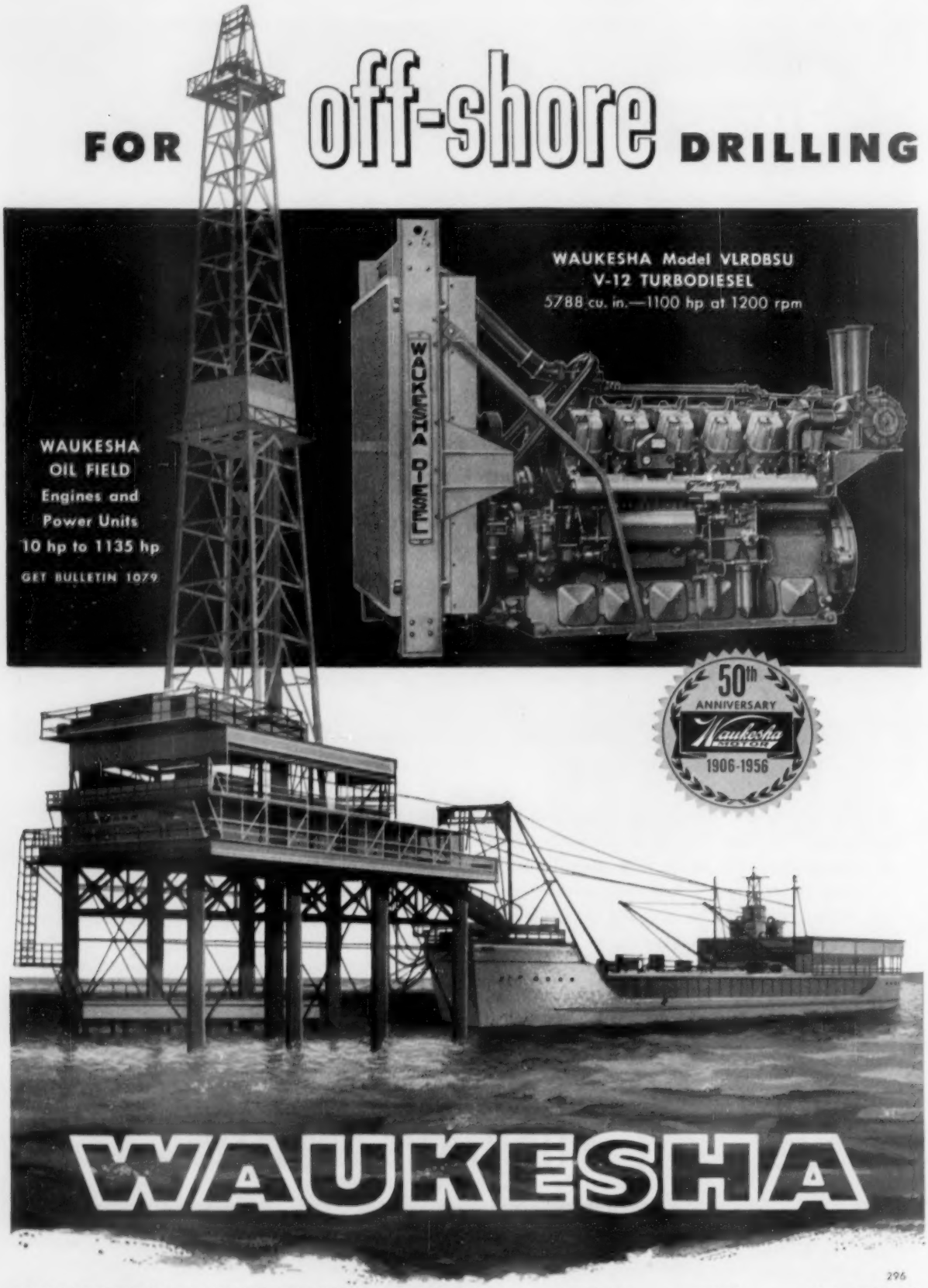
Struthers Wells

WARREN, PA.

Plants at Warren, Pa. and Titusville, Pa.

Offices in Principal Cities

FOR off-shore DRILLING



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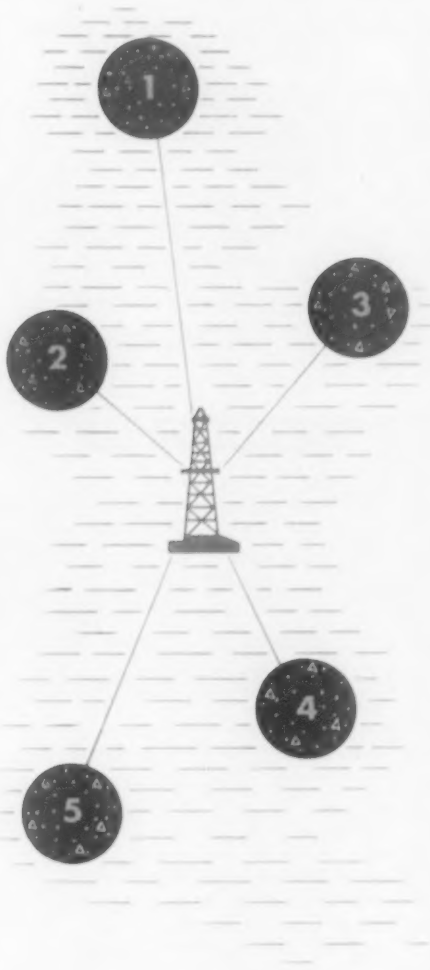
WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN • NEW YORK • TULSA • LOS ANGELES

when wells take

TOO MANY WATER SHUTOFF JOBS



SQUEEZE WITH HALLIBURTON'S DOC

(DIESEL OIL CEMENT)

If you are having trouble shutting off water from your wells, using large volumes of cement slurry, or requiring too many jobs for shutoff . . . then you will appreciate the advantages of squeezing with Halliburton's DOC – Diesel Oil Cement.

First reason for DOC's superiority as a water sealant: it makes for safe handling as the slurry remains fluid until contacted by water. Squeezing technique isolates slurry during pumping to place. When water zone is reached, slurry absorbs water with sponge-like action and sets rapidly. This saves volume since only the water zone itself is cemented and excess slurry can be reversed out. And squeeze pressures can be lower in most cases because DOC retains low viscosity until water is contacted.

Second reason: Halliburton's DOC contains a powerful surfactant called "DOC-1" which allows twice as much cement to be added to a given amount of oil. This gives a denser set material of extremely low permeability and high compressive strength.

To sum up – in weight and strength . . . in pumpability and setting characteristics . . . in amount of slurry used – DOC has the qualities that have given successful, economical squeezing under extremely difficult conditions. These characteristics were designed into DOC in the world's most experienced oil well cement laboratories . . . Halliburton's. For effective, economical water shutoff call your local or district office of the Halliburton Oil Well Cementing Company.

COMPLETE DATA SENT ON REQUEST

Get This Valuable Information

For Your Halliburton Service File

HALLIBURTON CEMENTING SERVICES

750 SERVICE CENTERS – JUST MINUTES AWAY FROM ANY RIG

HOW TO FIGURE THE COST OF STEAM TRAPS

STEAM TRAPS are something like wives. First, there is the cost of securing one and installing it in its new home. Then, there is the cost of maintaining it. Now, everyone knows that some wives are frugal and help their husbands a great deal, while others are frivolous spendthrifts. It is the same way with steam traps. You have to figure the original installed cost, the maintenance cost and the effect on general operation.

Divide the total expenses by life of the trap and you get down to the real heart of the matter—the *cost per year.* This is where Armstrong steam traps really shine! Let's take a look at the details:

DIRECT TRAP COSTS

1. First Cost. The price of Armstrong traps is low in terms of capacity. An optimum relationship between leverage, bucket weight, bucket travel and orifice size gives big capacity in a small package. Armstrong steam trap capacity ratings are based on *actual* tests with condensate at steam temperature and with actual hookups. They tell you what the trap will deliver *on the job.* This is not generally the case with other trap ratings.

2. Installation Cost. In four of the most widely used sizes, Armstrong traps are available in either side inlet—side outlet or bottom inlet—top outlet body styles, making possible the simplest, lowest cost installation.

3. Maintenance Cost. 40% less maintenance with Armstrong traps is the average of all the maintenance reduction reports secured from users over a period of years. This is due to high quality of parts, generous safety factors and inverted bucket know-how.

4. Repair Parts Cost. Armstrong heat treated chrome steel valve parts, precision ground and lapped, last a long time. When they do require renewal, a complete new valve mechanism right off the factory production line transforms an old trap into a new one at low cost.

INDIRECT COSTS

1. Cost of Steam Waste. This cost occurs through leaky trap valves, through traps that stick open or lose prime, through extra hours of operating heat transfer equipment due to poor drainage. This is a cost you can eliminate with Armstrongs.

2. Cost of Efficiency Losses. Poor trapping cuts heat transfer efficiency. Figure how much 10% loss affects the return on a $5000 production unit, or a $1,000,000 plant. Armstrong traps discharge condensate and air as fast as it accumulates, keep steam equipment at peak productive efficiency.

3. Cost of Downtime. Armstrong traps stay on the job long and faithfully, eliminating the production losses caused by excessive downtime for maintenance.

A steam trap casts a mighty big shadow that is multiplied by the number of traps in a plant until it has a major effect on operating costs. When you figure the costs from all angles you will find it pays to specify "traps shall be Armstrong."

FREE: STEAM TRAP BOOK

—44 pages of prices, design, selection, installation and maintenance data on Armstrong steam traps. You are welcome to a copy. Call your local Armstrong Representative, or write.

ARMSTRONG MACHINE WORKS

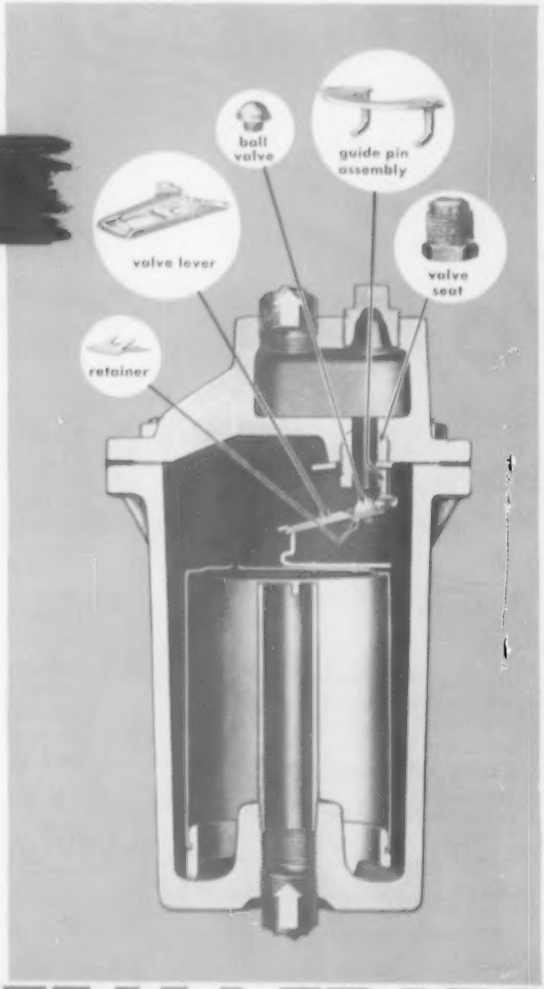
868 Maple Street • Three Rivers, Michigan

YOU CANNOT BUY A BETTER TRAP THAN AN ARMSTRONG . . .

Here Are Some Questions for Cost Comparison

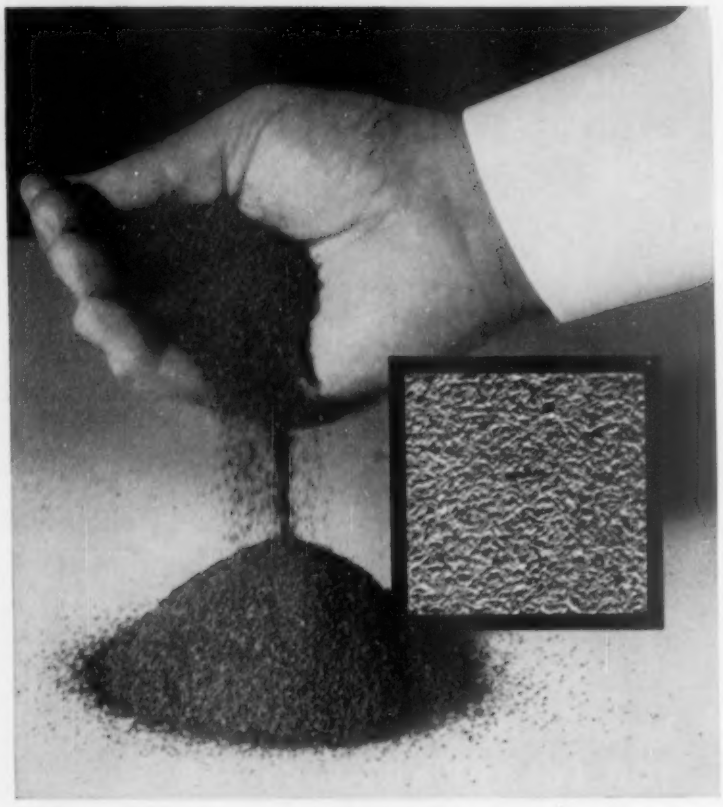
1. Will the valve stay steam-tight for 2 to 3, or even up to 10 years depending on the service?
2. Will the trap discharge condensate at steam temperature to keep equipment hot and minimize non-productive radiation losses?
3. Will the trap automatically discharge air in sufficient volume to keep equipment at peak temperature and to prevent corrosion?
4. Is there enough safety margin of power in the bucket and lever to open the trap when the orifice enlarges slightly due to wear?
5. Can the trap stick in open position?
6. Is the trap apt to lose prime?
7. Are the published trap capacity ratings accurate and reliable for trap selection purposes?
8. Will the trap cleanse itself of ordinary dirt and scale?
9. Is the trap easy to install, inspect and repair?
10. Is the trap unconditionally guaranteed to give complete satisfaction?

If the trap is an Armstrong, the answer to each of these questions is favorable!



ARMSTRONG STEAM TRAPS

Rough treatment proves



Rheem integrated drum linings can take it

Lined steel drums must often take more than body blows in shipment. Riding under a blistering sun one day, they may be standing in snow the next. And if a lining lets go, your customer might get a drumful of unusable goods.

In the Rheem laboratories, our engineers fight back. They take drums loaded with hard-to-handle products on special trips. Trips through 160° temperature shifts that end in shattering, waist-high drop tests. Out of this planned abuse come better lining materials – better *applied*, to hold on and take it.

That's how Rheem learned long ago good linings start with the steel. They blast their drums with high carbon steel shot, to scour and roughen the surface, and give the linings sawtoothed, naked grips. No sandwiched scale between lining and steel to invite flaking or peeling. Rheem linings can't slip or slide. They're *integrated*.

Extra step? We take lots of them. Like curing linings on our drum bodies and on their smaller tops and bottoms, in separate ovens for the individual treatment their different sizes require. Only *extra* steps lead to newer and better containers and product protection. We gladly take them. They've made us the world's largest manufacturer of steel shipping containers.

E. D. C. B. A.

Have a hard-to-hold product? Chances are our lab has a lining just right for you. They have A to Z experience in solving lining problems. Write today.

RHEEM MANUFACTURING COMPANY

5001 Jefferson Hwy., P.O. Box 4027, Carrollton Station, New Orleans 18, La.
1025 Lockwood Drive, Houston 20, Texas

NAME_____

COMPANY_____

POSITION_____

STREET_____

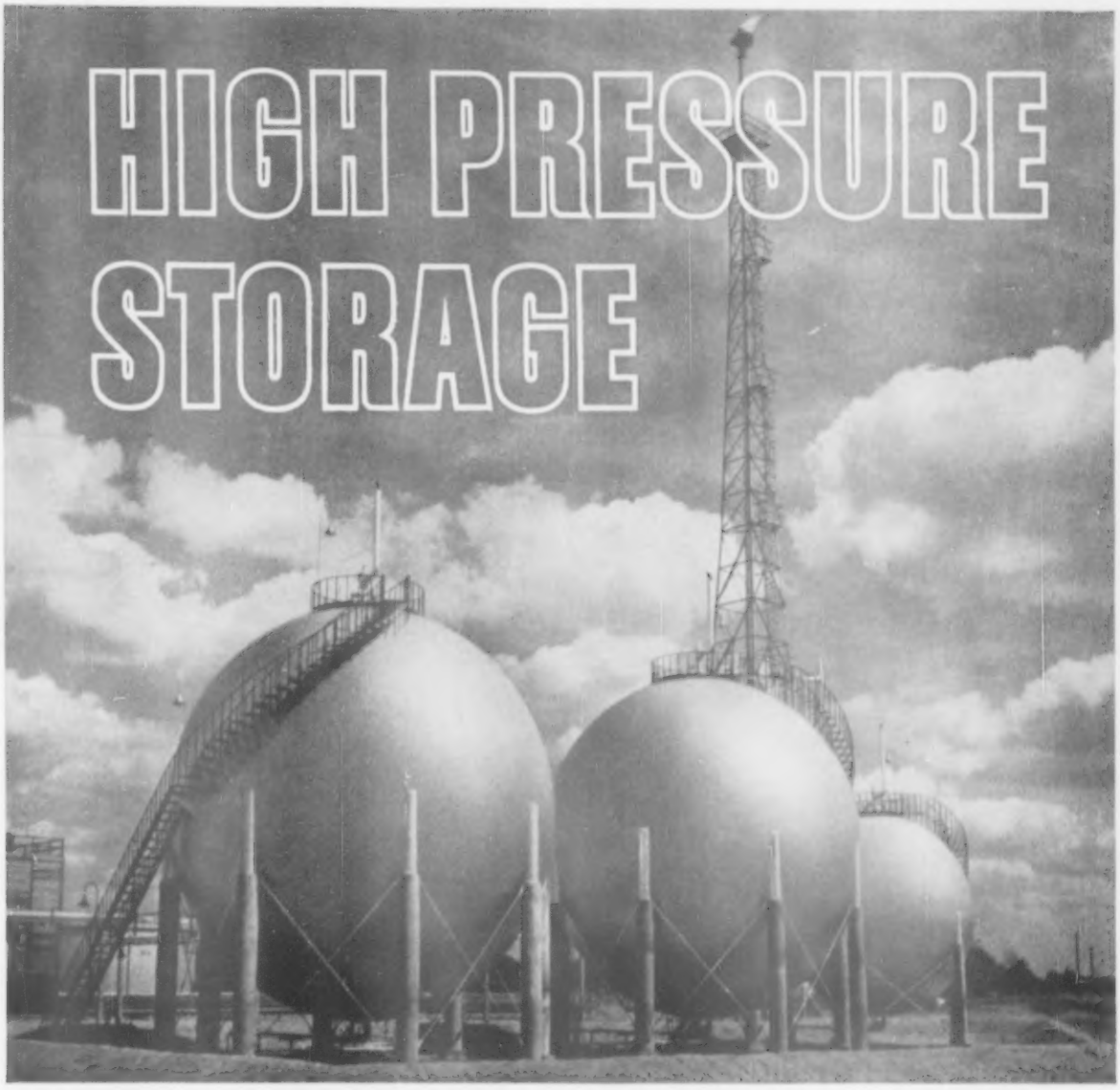
CITY_____ ZONE____ STATE_____

PRODUCT_____

OGJ-4

YOU CAN RELY ON Rheem MANUFACTURING COMPANY

RICHMOND AND SOUTH GATE, CALIF., HOUSTON, CHICAGO, NEW YORK, NEW ORLEANS, LINDEN, N. J. AND SPARROWS POINT, MD.



GRAVERSPHERES

solve gas and liquid storage problems

For pressure storage of process butane, iso-butane, natural gasoline and other volatile liquids and gases, Graverspheres are a "natural."

Graverspheres are formed in Graver shops and are first carefully assembled to insure accurate fit. After this they are shipped to location, erected and field-welded.

These spheres—the very shape of which is ideal for high-pressure storage in quantity—are available in capacities from 1,000 to 30,000 bbl. For gas storage Graverspheres are made to withstand pressures up to 100 p.s.i.g. and for liquid storage from 20 to 90 lb. water pressure.

As is the case with Graver tanks, towers and pressure vessels, traditional Graver quality and craftsmanship are inherent in Graverspheres.

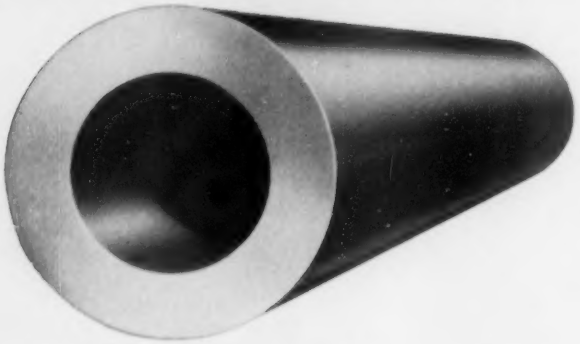
GRAVER TANK & MFG. CO., INC.
EAST CHICAGO, INDIANA

CHICAGO • NEW YORK • PHILADELPHIA • EDGE MOOR, DEL.
PITTSBURGH • CLEVELAND • DETROIT • TULSA • SAND SPRINGS, OKLA. • HOUSTON • CASPER, WYO. • LOS ANGELES • FONTANA, CAL. • SAN FRANCISCO

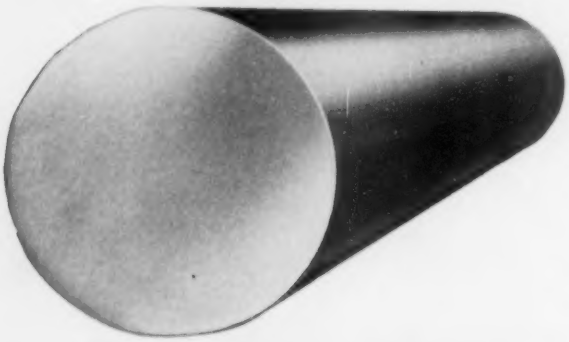
GRAVER builds tanks, towers and pressure vessels for the chemical and petroleum industries

When you make hollow parts . . .

Start with seamless tubing



instead of bar stock



Save steel, machining time!

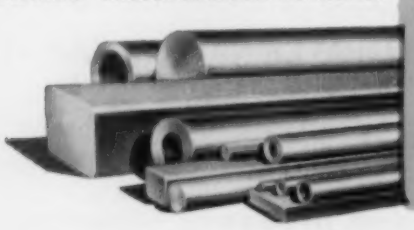
WHEN you make hollow parts from bar stock, you waste time boring the center hole—you waste steel because you have to throw away the chips you bore out. Why not do it the easy, economical way? Start with Timken® seamless tubing. The hole's already there! Finish boring is often the first production step. You cut machining time—get more parts per ton of steel.

With Timken seamless tubing, your machine tools are more productive. Screw machine stations normally used for drilling can be released for other jobs. You get added machine capacity without additional machines.

To make sure you save even *more* steel, our engineers will study your problem and recommend the most economical tube size for your hollow parts job, guaranteed to clean up to finish dimensions.

You also get the highest internal quality with Timken seamless tubing. The piercing process by which it's made is basically a forging process. Result: a uniform spiral grain flow for greater strength and a refined grain structure which brings out the best quality of the metal. And the Timken Company's rigid control keeps the quality uniform from tube to tube and heat to heat. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



TIMKEN
Fine Alloy
STEEL

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

WATCH FOR THIS SIGN OF A SPECIAL BUY

Recently, one of the National Supply Store managers literally "reached the end of his rope." So he gathered all the rope end remnants in stock, attached some National "money saving special" tags, and offered them at a big discount. In a matter of hours, the counter was cleaned off.

You won't often see these money saving special tags in any of our 126 stores. One reason, of course, is that merchandise moves rapidly. But the main reason is wrapped up in our store operation policy that is, in effect, a constant bargain for every customer.

Each National Store has a complete line of equipment and operating supplies that's tailored to the needs of the area it serves. A store's stock is never static, but constantly changed to bring you the newest developments in appropriate products.

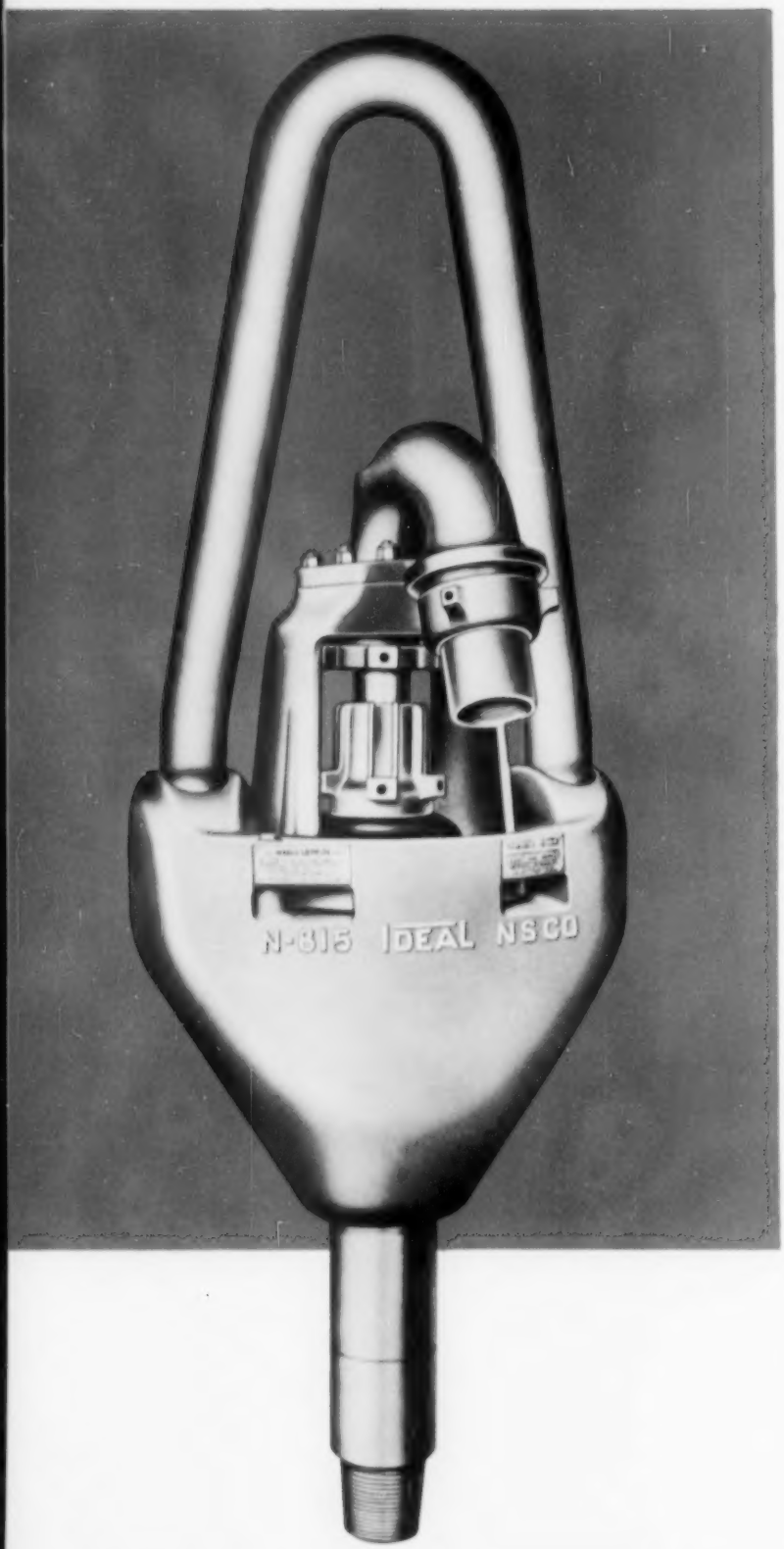
Moreover, we insist on top quality products—from the major equipment in our own "National Blue" products family to the smallest accessory item you can name. We constantly try to anticipate your operating needs and give you the best possible benefits in prices and service.

Such a policy makes *everything* in a National Store a good buy—and thus we reserve the tags only for special situations and products like the rope ends. Actually, we could put bargain tags on all items—so convinced are we of their lasting service value to you.

But you, the customer, are the best and final judge of this. Your use of, and consistently high regard for, National Supply products and services has made us the world's largest manufacturer and distributor of oilfield machinery and equipment.

THE
NATIONAL SUPPLY
COMPANY

6 reasons why you'll reduce drilling



The simple, compact design of Type N Swivels is typical of the built-in safety of products bearing the Ideal trademark. But this general feature only partially explains their true worth on any rig. Here are six main reasons why these Swivels give you continuous service at low operating and maintenance costs:

1. Reduced weight

Complete redesigning has been employed to bring every model down to minimum weight in relation to individual rated capacity. The use of high quality, high-strength components throughout has reduced both over-all height and weight to greatly facilitate handling.

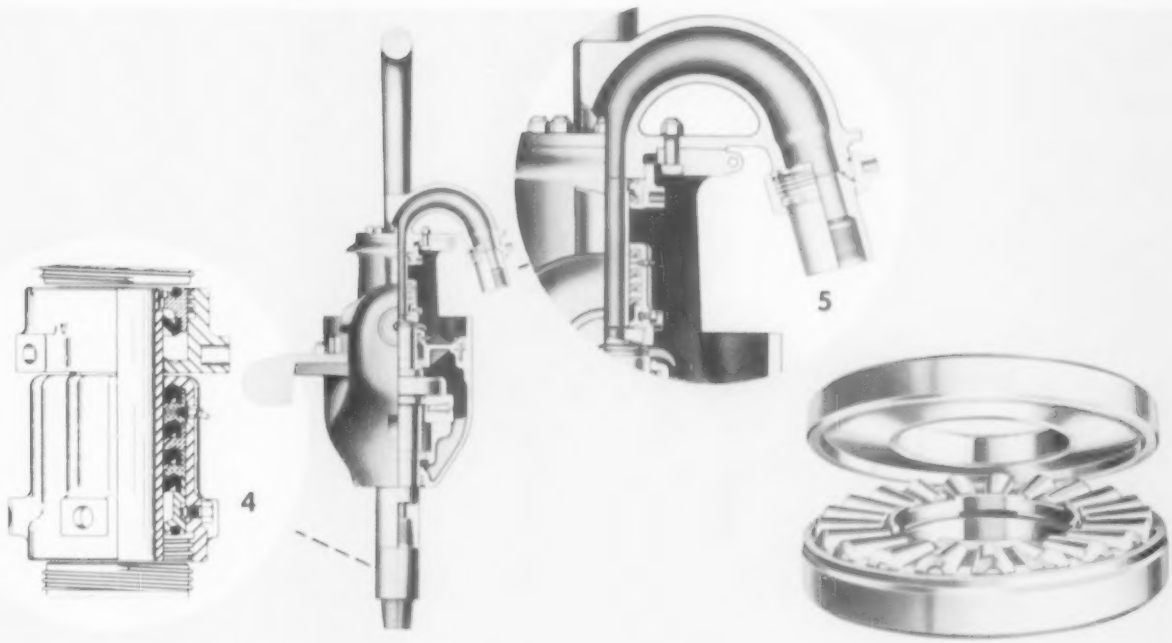
2. Lower center of gravity

Centerline of the bail pins on Type N Swivels has been raised, thereby lowering center of gravity. This means greater stability in handling, makes connection of swivel "sub" to kelly easier and faster.

3. Streamlined exterior

The one-piece steel body is free from any dangerous projections. All bolts, nuts, pins and grease fittings are recessed to assure maximum safety to the derrick crew.

costs with National's Type N Swivels:



4. Fast wash pipe replacement

National's exclusive Uniflex Wash Pipe Box assembly is standard on all Type N Swivels. Its Nationaloy wash pipe is of the free-floating type. The packing assembly has inverted rings and provides an improved method for packing off the mud. The Uniflex assembly also has quick-acting threads to speed replacement, is easily assembled by one man, can be installed without removing the gooseneck or breaking the hose connection.

5. Rapid hose coupling

Also standard on all Type N Swivels is the Quick-Seal Hose Connection that speeds make-up of hose joints. All parts are made of steel, and are plated to minimize corrosion and galling of threads. Besides eliminating one hose connection member and therefore minimizing the chance of mud leakage, the Quick-Seal Connection features larger, quick-acting threads and sealing elements to withstand rugged use.

6. Precision main bearing

This bearing is the perfected result of 40 years of National experience in design, manufacture and field performance. Made of highest quality steel, it is precision-machined throughout, and constructed to withstand the extreme loads and high rotating speeds found in modern drilling. A patented spherical contour on the outer end of the rollers draws lubricant between roller and race plate to minimize friction and wear.

There's a Type N Swivel for every drilling job!

Whatever the drilling job, there's a Type N Swivel to economically suit your needs. Check the chart on the right, and get more information on your choice from a National Supply representative.

Type	Depth Range, Feet	Comparative Dead Load, Tons
N-24	2,000– 4,000	110
N-35	3,000– 5,000	150
N-47	4,000– 7,000	200
N-69	6,000– 9,000	300
N-815	8,000–15,000	400
N-1324	13,000–24,000	500

THE
NATIONAL
SUPPLY
COMPANY

MAIN OFFICE: Two Gateway Center, Pittsburgh 22, Penna.
DIVISION OFFICES: Denver, Ft. Worth, Houston, Toledo, Tulsa, Torrance
CANADA: The National Supply Company, Ltd., 200 F. W. Clark Building, 709 Eighth Avenue, West, Calgary, Alberta
EXPORT: 600 Fifth Avenue, New York 20, N.Y., U.S.A.; City Wall House, Chiswell Street, London E. C. 1
NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE AND ELECTRICAL CONDUIT

next page: National's dependable Blocks

For new drilling speed and safety, use National's Blocks!

If you're losing time and money because of slow or unsafe block operation, National's line of Hook Blocks and Traveling Blocks can solve your problems. Every block is engineered for safety, built for rugged service and thoroughly field-tested. You can choose from a complete line of Hook Blocks and Traveling Blocks that National has developed for every drilling need, and get these outstanding features:

SPECIAL HOOK FEATURES

- Hook body mounted on tapered roller bearings
- Elevator link supports equipped with positive retaining links
- Automatic-latching hook tongue cannot be accidently opened
- Spring-actuated 8-position rotation lock
- Grooved hook body facilitates drill pipe alignment with elevator

TRAVELING BLOCK FEATURES

- Sheaves independently mounted on tapered roller bearings
- Individual lubrication to each sheave bearing
- All parts securely locked for safety
- Streamlined—all nuts, bolts, pins and fittings recessed
- Short, low stressed pins and shafts

Your National representative will be glad to give you more information about National's line of Hook Blocks, Traveling Blocks and companion Crown Blocks. Ask him soon about the units that can put new speed and safety into your drilling program.

THE
NATIONAL SUPPLY
COMPANY

MAIN OFFICE: Two Gateway Center, Pittsburgh 22, Penna.
DIVISION OFFICES: Denver; Ft. Worth; Houston; Toledo; Tulsa; Torrance
CANADA: The National Supply Company, Ltd., 200 F. W. Clark Building, 709 Eighth Avenue, West, Calgary, Alberta
EXPORT: 600 Fifth Avenue, New York 20, N.Y., U.S.A.; City Wall House, Chiswell Street, London E. C. 1

NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE AND ELECTRICAL CONDUIT

Type E
HOOK BLOCK

Designed to effect the greatest possible saving in vertical derrick space, this 200-ton rated block is typical of the Type E line. Type E blocks are available in three sizes for 90- to 200-ton loads. A complete line of Type E traveling blocks is also available.

Type F
TRAVELING BLOCK

Typical of National's Type F series blocks, this 450-ton capacity traveling block is designed to remain stable in operation even under no load. Type F blocks are available in two sizes for 300- to 450-ton loads.

Type F
UNIVERSAL HOOK BLOCK

The swivel block "universal" pin joint feature in this heavy-duty, 450-ton rated block distinguishes it from rigidly connected hook and block combinations. Type F Universal Blocks are rated for 300- to 450-ton loads.

Hydreco Gear Type Pump and Dudco Dual Vane Fluid Motor.

Petroleum Production Moves Forward with Power

FLUID POWER

Time schedules for modern exploration, drilling, production and pipe line operation leave no room for equipment that does not best combine Safety, Flexibility, Speed and Economy. Thus, Fluid Power gets the call to provide thrust or rotary motion for drill rigs, rotary tables and winches . . . for drives and controls on portable equipment and vehicles . . . for power to drive pumps, generators, mixers and actuate valves along pipe lines.

The KALAMAZOO Division of The New York Air Brake Company produces DUDCO and HYDRECO components for improved hydraulic circuits on all types of field and production equipment. DUDCO Dual-Vane Pumps and Motors for 2000 psi continuous duty . . . HYDRECO Gear Type Pumps and Motors, Control and Auxiliary Valves and Hydraulic Cylinders for 1000/1500 psi circuits.

In addition to this advanced type Hydraulic equipment, The New York Air Brake Company contributes a broad range of liquid Handling Pumps and world-famous Kinney High Vacuum Pumps to Petroleum production.

Here, for the oil man to choose, are Aurora Turbine and Centrifugal Pumps and Kinney Heliquad Gear and Rotating Plunger Pumps . . . equipment to solve the problems of "pumping any substance that will flow through a pipe." And, for de-aerating, dehydration, vacuum distillation, refrigeration and many special petro-chemical processes . . . Kinney High Vacuum Pumps.

KALAMAZOO DIVISION
Kalamazoo, Mich.
HYDRECO Gear-Type Hydraulic Pumps, 3 to 120 gpm; Fluid Motors, 3 to 52 hp; Cylinders; Control and Auxiliary Valves; 1500 psi. DUDCO Dual-Vane Hydraulic Pumps, 3 to 120 gpm; Fluid Motors, 7 to 140 hp; 2000 psi operation.

WATERTOWN DIVISION
Watertown, N. Y.
Railroad air brake valves for freight and passenger equipment, STRATOPOWER Hydraulic Pumps for Aircraft, to 3000 psi.

AURORA PUMP DIVISION
Aurora, Ill.
Liquid Handling Pumps, Centrifugals and deep well Turbines, 7000 gpm, 500 ft. heads. Turbine-type, 150 gpm, 600 ft. heads. Condensate Return Units.

KINNEY MANUFACTURING DIVISION
Boston, Mass.
Rotating Plunger and Heliquad Liquid Handling Pumps, to 3000 gpm. Vacuum Pumps, 0.2 micron, evacuate 1800 cfm.

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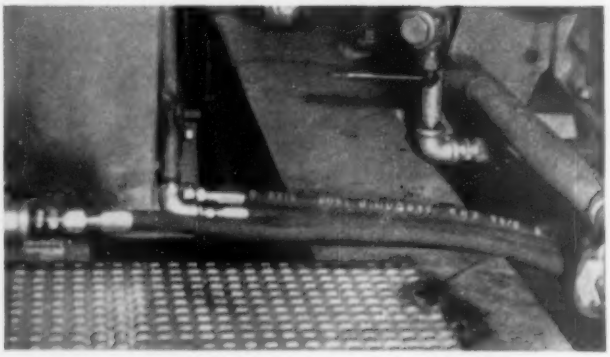
Aeroquip Flexible Hose Lines Add Dependability, Reduce Downtime

ON CARDWELL'S NEW S-350 AND J-450 DRILLING RIGS

The use of Aeroquip hose lines on Cardwell Manufacturing Company's newest drilling rigs offers two important advantages: (1) Aeroquip's rugged quality means longer, more dependable service; (2) Replacement lines can be made quickly, right on the job.

With Aeroquip you make hose lines for all makes and types of oil field equipment as you need them, from a small supply of bulk hose and reusable fittings. Inventory is reduced, downtime is minimized. See your Yellow Page Directory for your Aeroquip distributor, or write for Bulletin No. 153.



Aeroquip

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AEROQUIP CORPORATION, JACKSON, MICHIGAN

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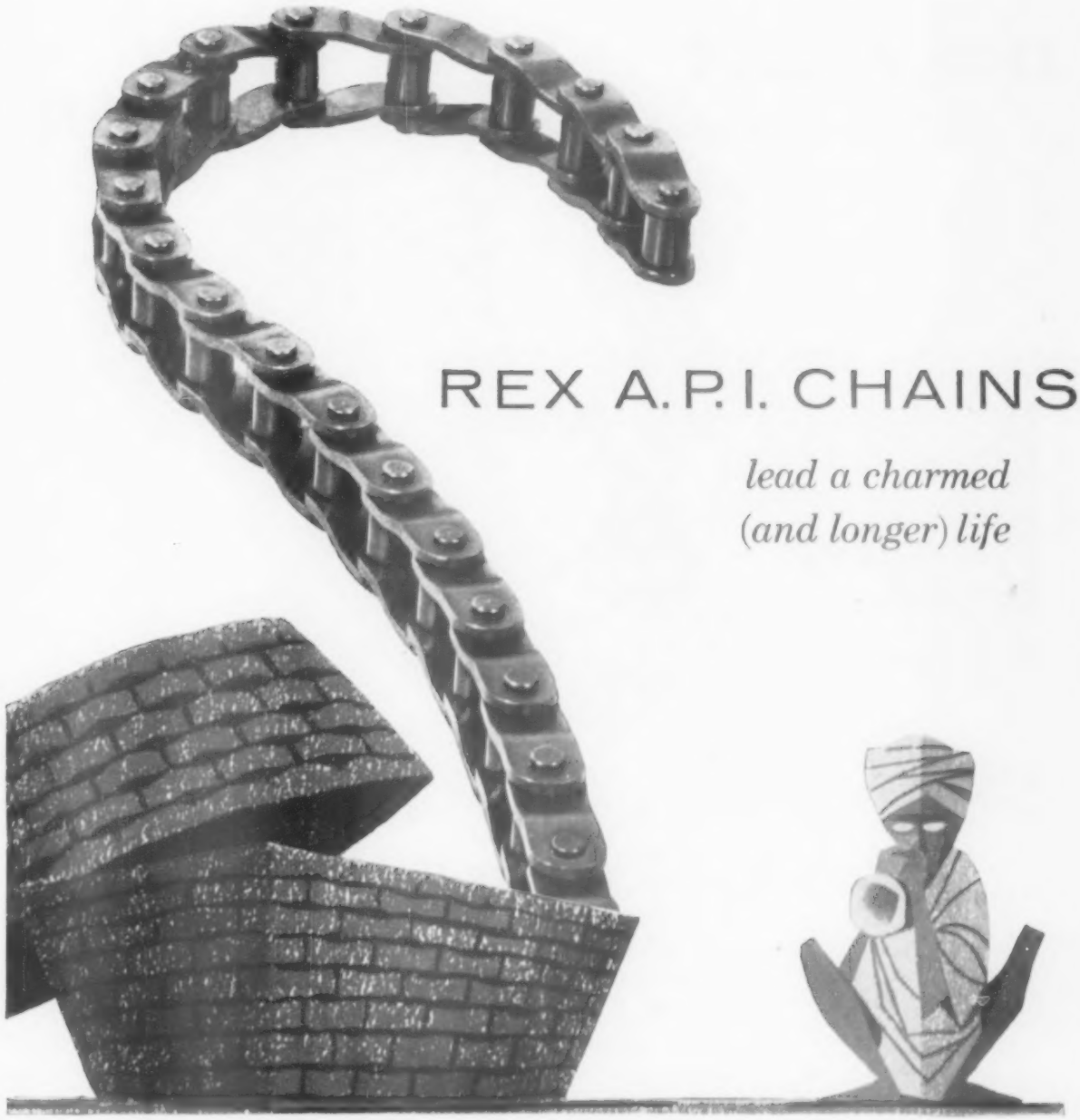

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The famous Rex 3-diameter pin makes assembly and disassembly a simple job. You'll get better performance, service and lower costs per foot of hole drilled when you use the best A.P.I. chain—Rex®! See your supply store, Rex Field Sales Engineer, or write for oil field Catalog 55-3. CHAIN Belt Company, 4619 West Greenfield Ave., Milwaukee 1, Wis.

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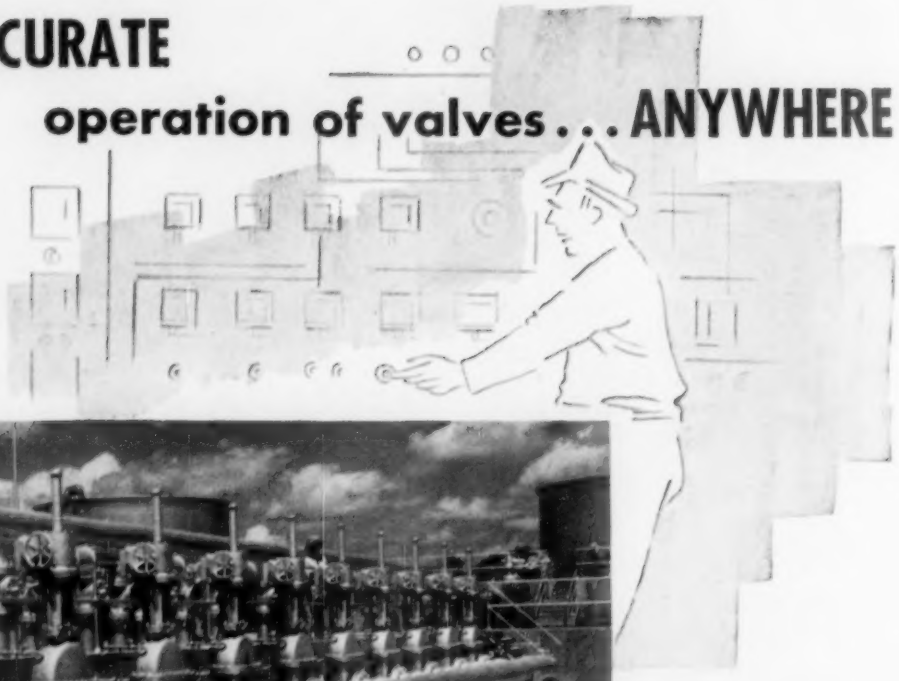

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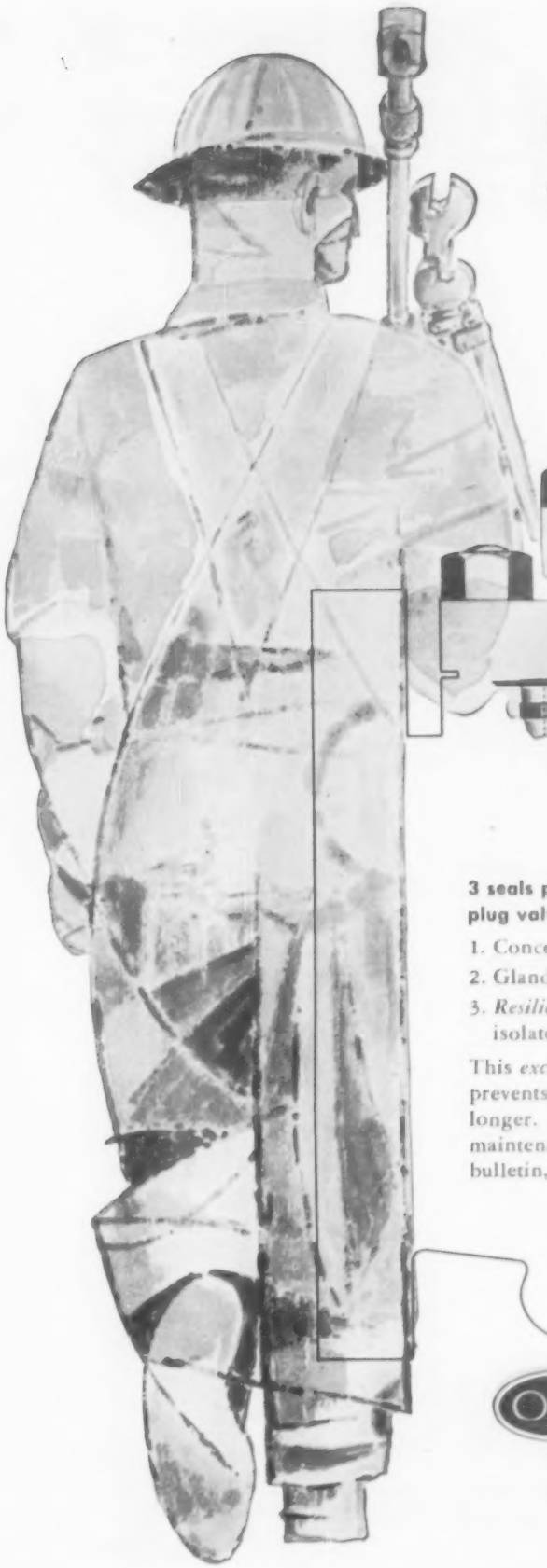
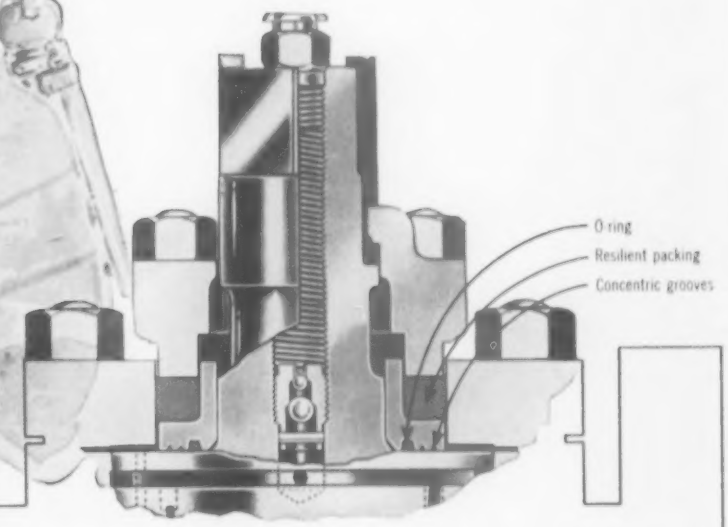
LimiTorque Valve Controls

Established 1892



He'll tell you they don't leak



...here's why

3 seals prevent shank and gland leaks on OIC lubricated plug valves.

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2. Gland liner also retains an *O-ring*—a second seal.
3. *Resilient packing* forms a third seal . . . is completely isolated from all moving parts.

This *exclusive* OIC lubricated plug valve design not only prevents shank leaks, it also helps retain gland adjustment longer. That's why OIC plug valves rate high with maintenance men. For details write for the new OIC bulletin, Form No. 1003-R.

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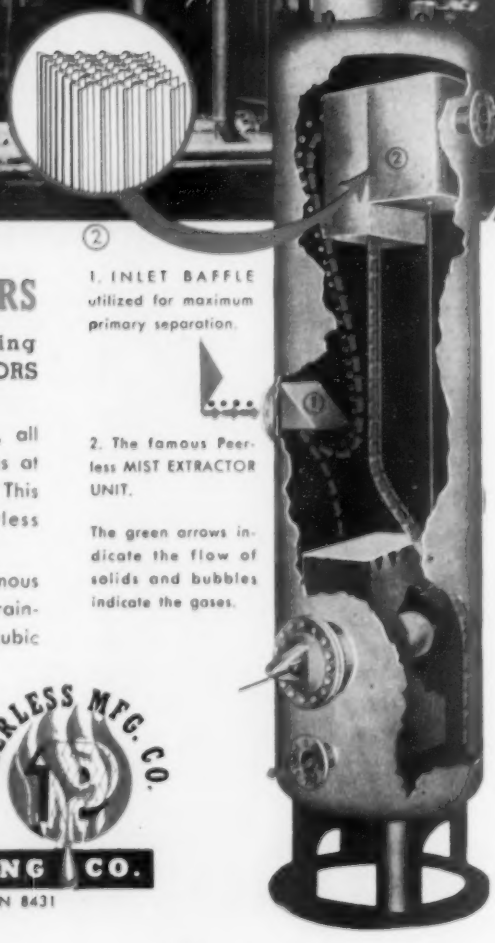
FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES

PEERLESS SEPARATORS

ALL 9 OF 'EM!



1. INLET BAFFLE utilized for maximum primary separation.

2. The famous Peerless MIST EXTRACTOR UNIT.

The green arrows indicate the flow of solids and bubbles indicate the gases.

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Each Peerless Separator is designed and built around the famous Peerless Mist Extractor Unit, which guarantees the liquid entrainment loss to be less than 1/10 gallon per million standard cubic feet of flowing gas. The cutaway to the right illustrates the flow of gas through a Peerless Separator and how this Mist Extractor is used.

Write for Separator Bulletin 201

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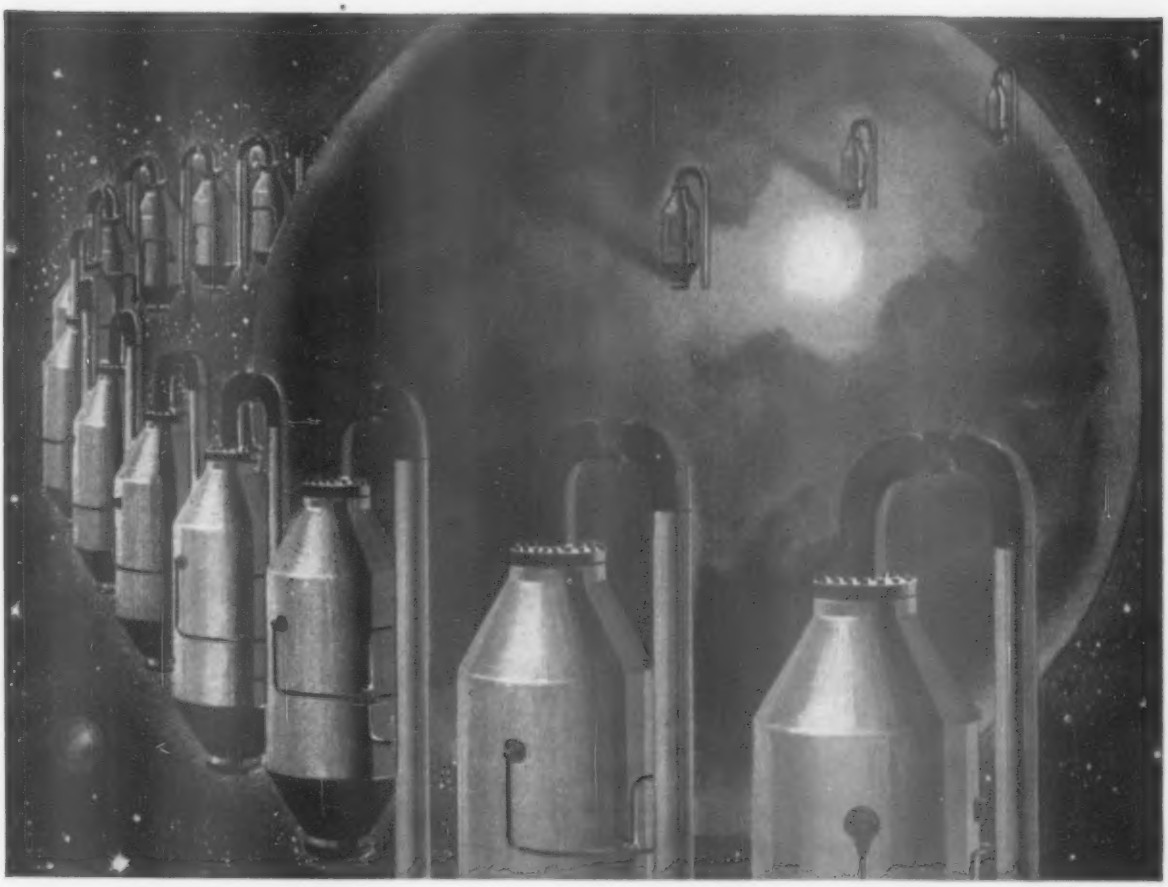

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it's the CATALYST that counts

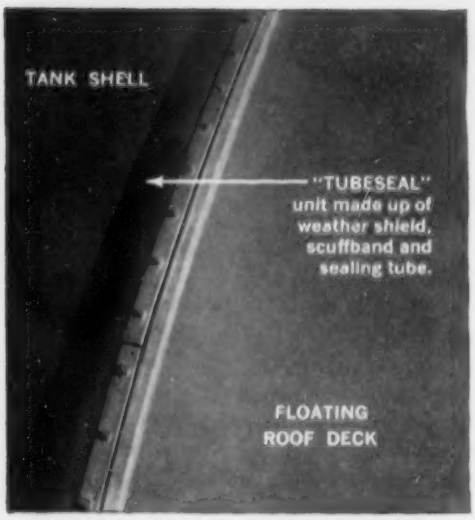
ATLANTIC

RESULTS CONVINCED

In 1954 the "X" Company* bought

TO DATE THEY HAVE PURCHASED 20 ADDITIONAL TUBESEALS

...on the basis of proved performance!



Looking down on Hammond Tubeseal in position on Floating Roof tank. Neoprene weather shield and ribbed scuffband protect oil-filled sealing tube, which is in continuous contact with product, thereby eliminating vapor space.

* **One of the nation's largest oil companies. Name on request.**

† **Patented**

UNUSUAL? No, merely typical of the many new users who are adding fresh chapters to Tubeseal's exciting "success story." And no wonder! Tubeseal is the **only** floating roof that eliminates vapor space while providing a **positive** seat at all points between the roof, shell and product. No vapor-air mixture can lurk above the product—because there is no space for vapor to form.

Think of the advantages this offers! Regardless of the product you are storing—vapor losses simply can't occur. And with products of intermediate volatility, such as jet fuels, the dangers of exploding vapors and rim fires are practically non-existent.

NO CORROSION
NO MECHANICAL MAINTENANCE
CLIMATE PROOF

In contrast to conventional metal shoe seals, where rusting and corrosion shorten seal life and create contamination, the Tubeseal is completely non-corroding. Nor will it scuff, abrade or injure the interior tank surface. And because it has no moving parts, there is no mechanical maintenance required.

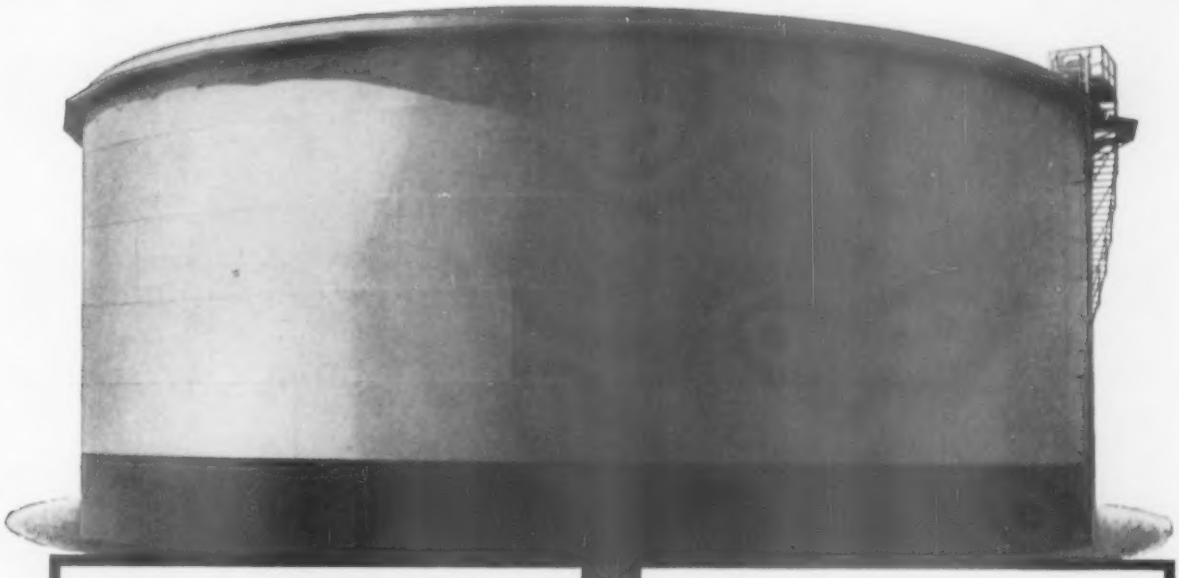
Tubeseal Floating Roofs can be efficiently used on all types of new and existing tanks—even those of riveted construction where metal shoe seals are particularly inadequate. The liquid-filled tube quickly adjusts to irregular shapes, overcoming any tank out-of-roundness.

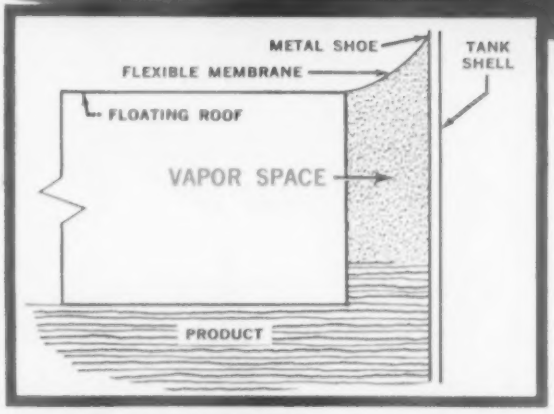
Whether you are storing gasolines, jet fuels, sour crudes, light crudes, alcohol, naphthas, polyesters or similar products, Tubeseal is **the most efficient and positive seal known.**

BUILT TO YOUR SPECIFICATIONS...GUARANTEED TO YOUR SATISFACTION!

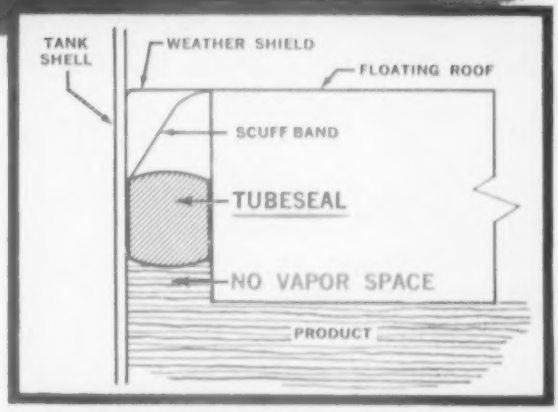
THIS MAJOR REFINER*...

ONE Tubeseal† Floating Roof Tank





Conventional floating roof tank has space between flexible membrane where air-vapor mixtures form. Because metal shoe and membrane cannot be absolutely gas tight, vapor is constantly escaping. This condition causes excessive corrosion, may also result in fire from lightning or other source.



HAMMOND TUBESEAL FLOATING ROOF entirely eliminates every space where air-vapor mixtures can form. **Hammond Tubeseal** completely fills space between product surface and roof seal, so that corrosion is stopped (even for sour crudes), and vapors **cannot form—hence cannot ignite or be lost.**

HAMMOND TUBESEAL COSTS NO MORE IN THE FIRST PLACE

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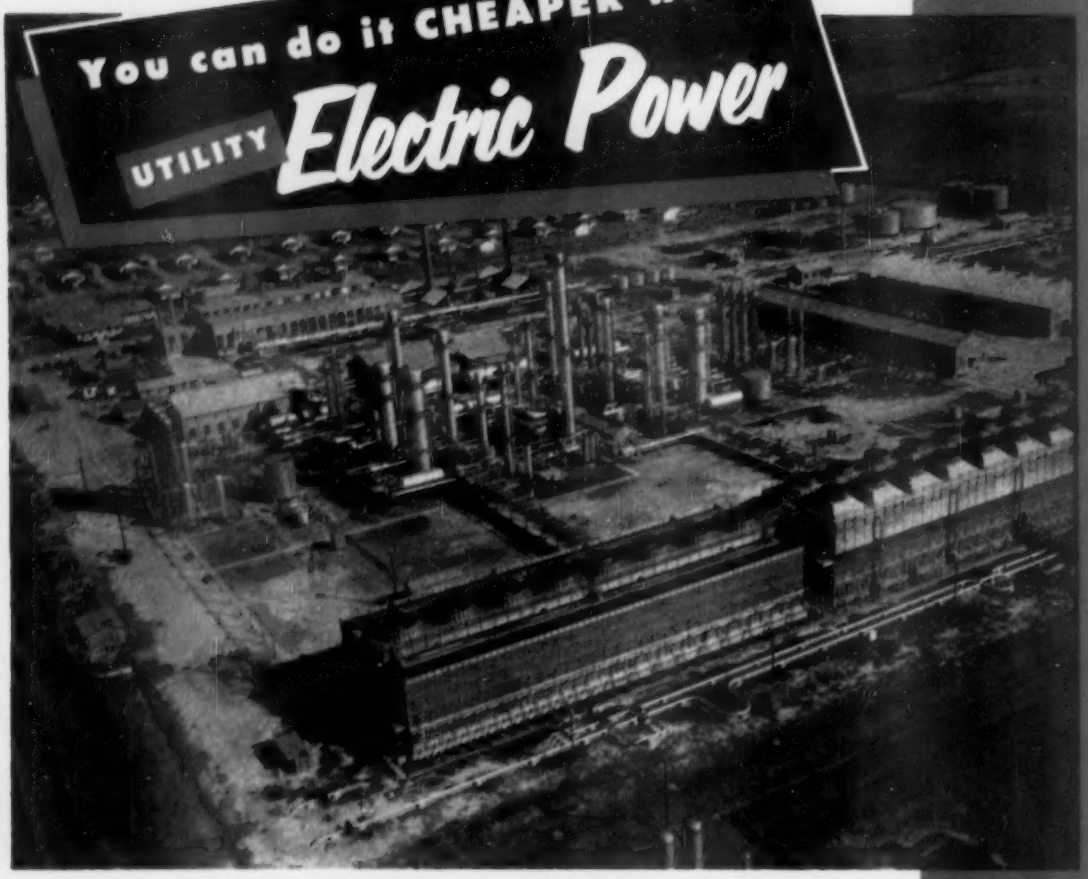

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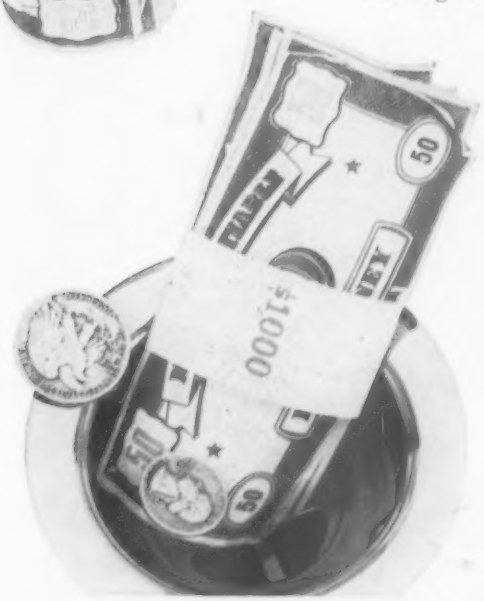
Savings also are often possible with customers who buy solid and flake caustic.

The important thing is to do something about it now. It will cost you nothing to find out. Our Technical Service Department will be glad to assign one of its specialists to discuss your individual case, to make recommendations and to estimate your annual savings.

Write today to our Caustic Soda Department at the Pittsburgh Office.



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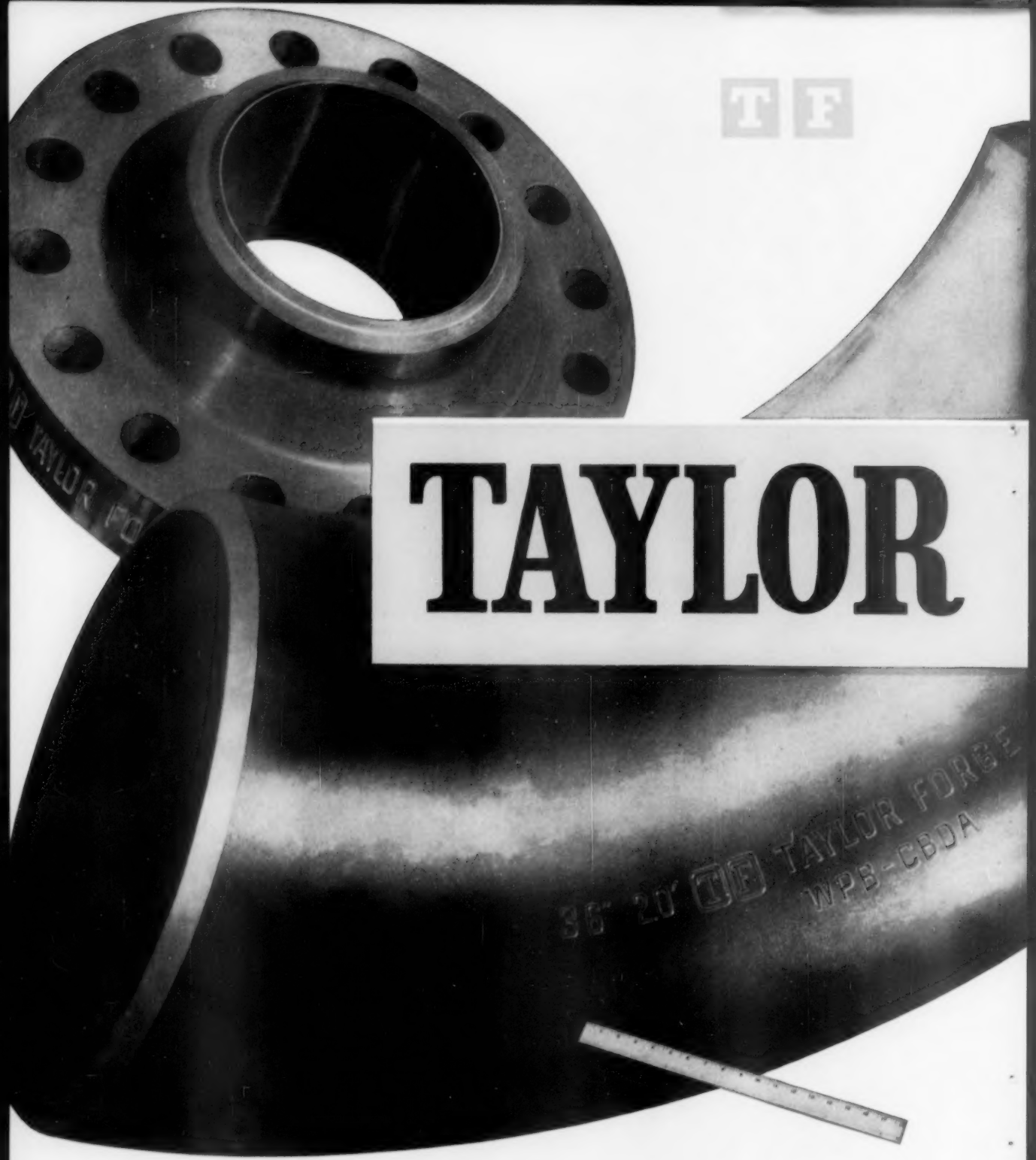


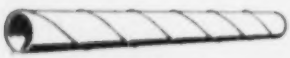
Welding nozzles

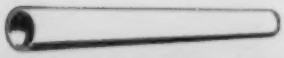
T.E.M.A. flanges and channels

Multiple outlet headers

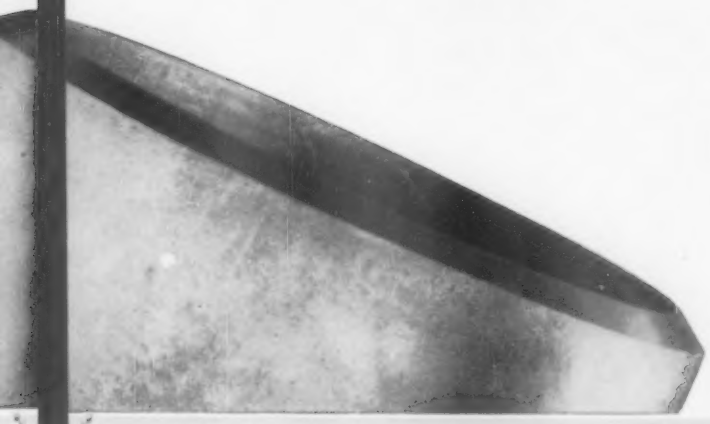
Production forgings

Venturi reducers


Spiral weld pipe


Large diameter electric weld pipe

Welding necks



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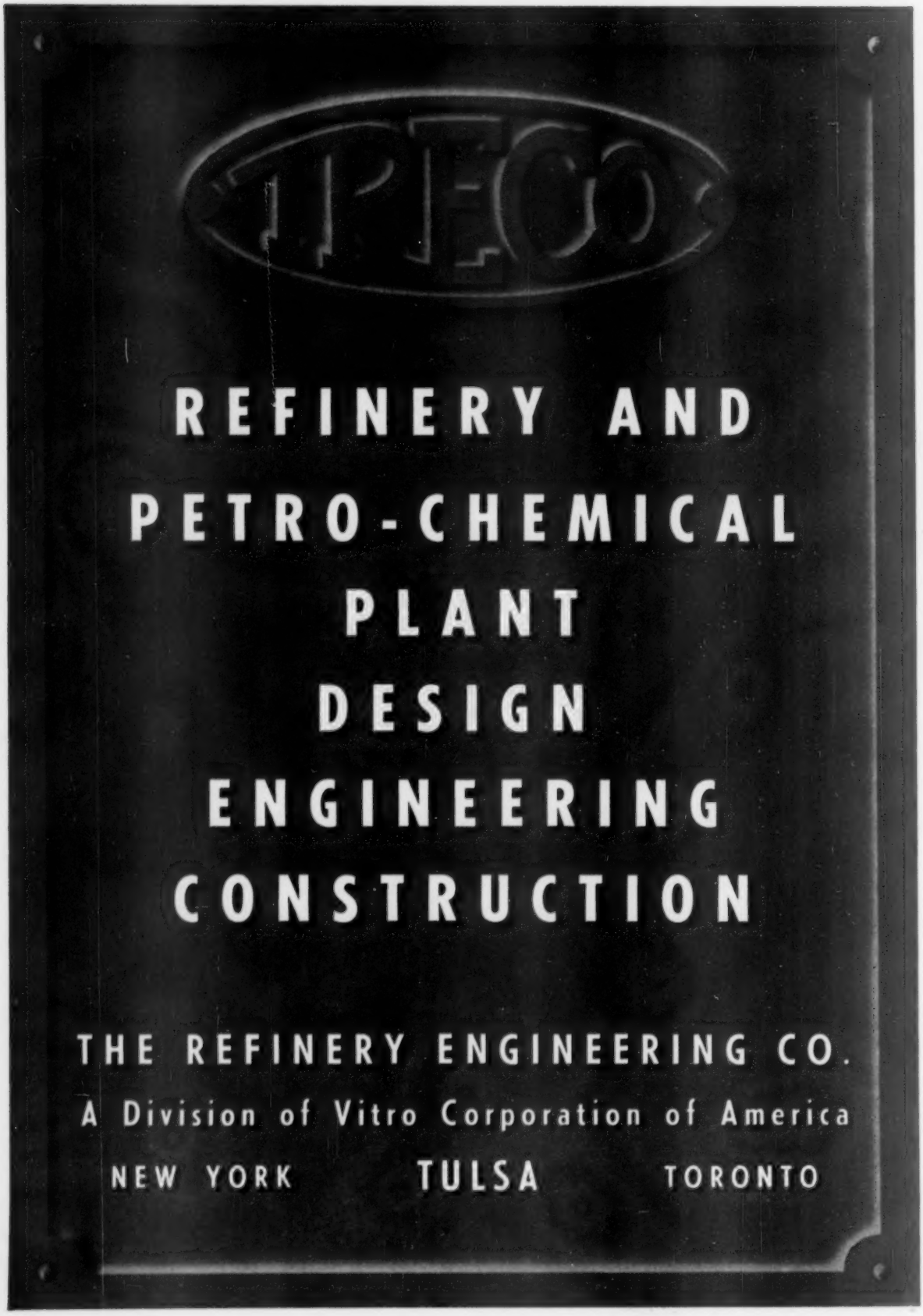
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For your free copy, write Dept. OS-128.

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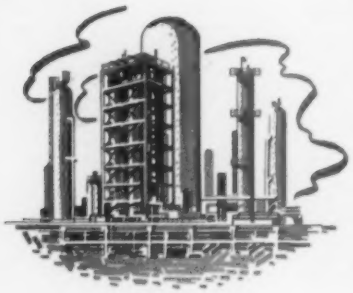
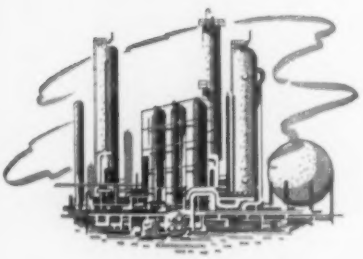
for the PETROLEUM, CHEMICAL and PROCESS Industries





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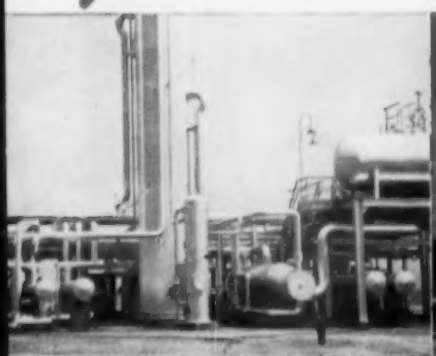

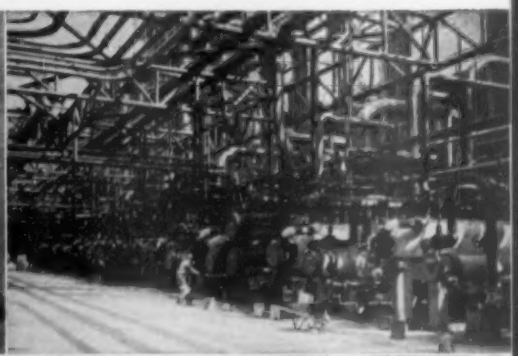

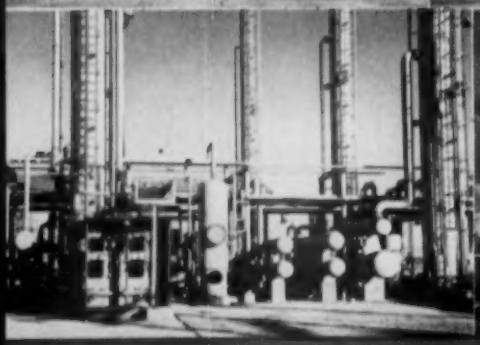

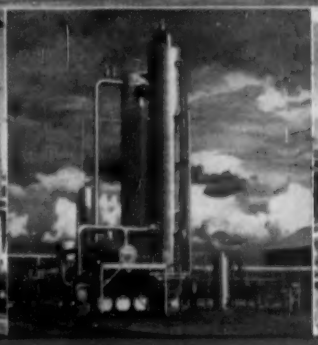

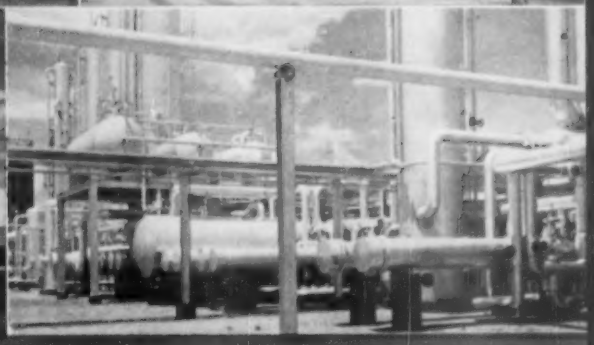

API-ASME and ASME Code Construction

Get Higher Factor of Safety with New VHS Rotary Drilling Lines

• One of the many benefits drillers get with new VHS rotary drilling lines is higher factor of safety. For this new drilling line is 15% stronger than Improved Plow Steel—the strongest grade available before the introduction of VHS.

This means that 10 lines of VHS have a factor of safety 15% greater than 10 lines of the same diameter of IPS. Or, to put it another way, 10 lines of VHS have a factor of safety roughly equivalent to 12 lines of IPS.

TOUGHER, TOO!

New Lay-Set VHS is not only stronger, it's also tougher—and therefore it has higher resistance to peening, and greater resistance to abrasion. Both of these are important factors in maintaining shape and diameter. If regular adaptable cut-off practices are followed, ton-mile advantages should result.

CUT "DOWN TIME"

With new Lay-Set VHS you can drill deeper before increasing the number of parts of line. And VHS's extra strength eliminates, in many cases, any necessity for buying new blocks or regrooving sheaves to use larger diameter lines for higher safety factor.

SIMPLE TO ORDER

You don't need any complicated specifications to order new Lay-Set VHS drilling lines. Just call your Hazard Distributor and tell him the length and diameter you want. He probably has it in stock—or he can get it readily.

for further information write to the nearest Hazard office for Brochure DH-522

LAY-SET VHS

15% Stronger • Tougher •

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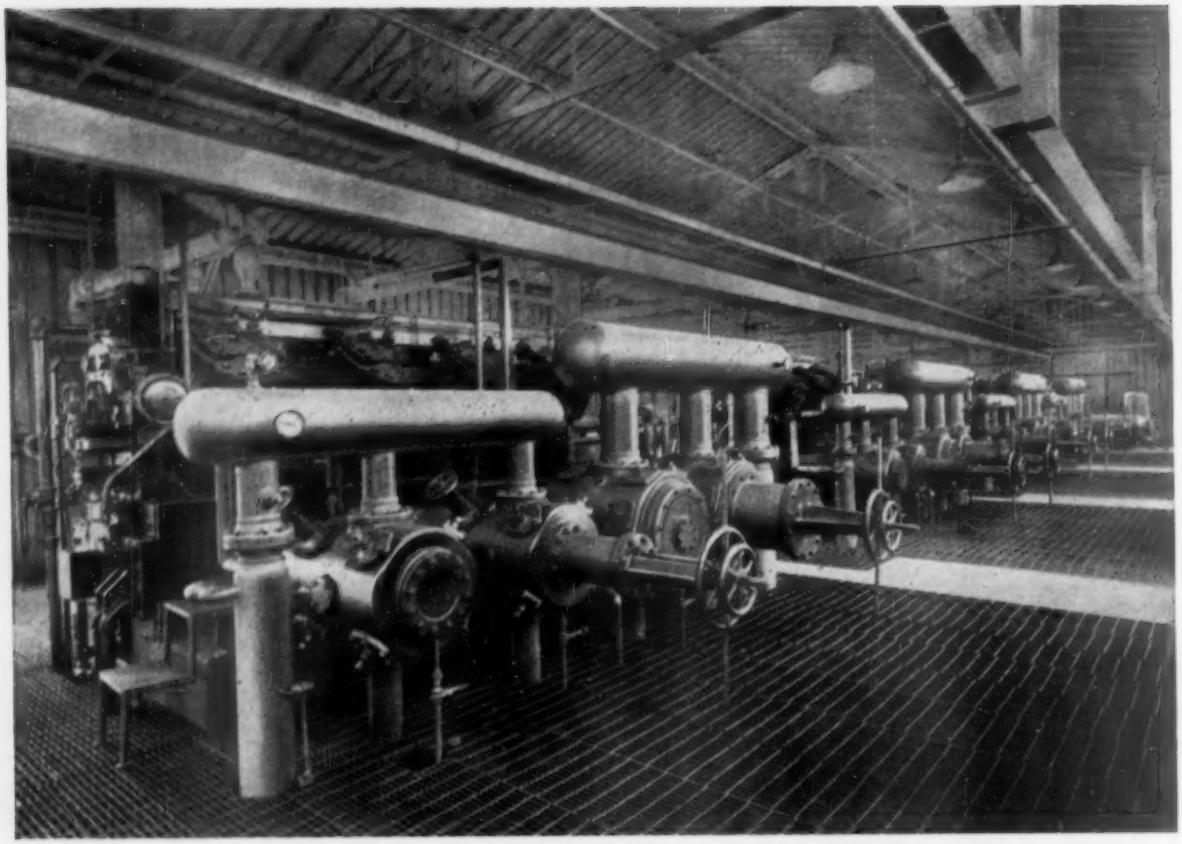

SVG gas-engine compressors maintain critical pressures on cat-cracker gas recovery

for National Cooperative Refinery Association

Gas recovery compressors in a catalytic cracking plant must hold constant suction and discharge pressures—a job made difficult by widely-fluctuating volumes flowing through the plant. This problem was solved for the National Cooperative Refinery Association at McPherson, Kansas, by Ingersoll-Rand engineers and SVG gas-engine compressors.

Ingersoll-Rand provided a special control system which keeps suction pressure constant by a choice of several methods, depending on plant conditions. SVG compressors are particularly suitable for such service because of the smooth operation and flexibility of I-R 4-cycle design. Regardless of speed or load, smooth power is maintained automatically by the constant-quality mixing valve. And the famed Ingersoll-Rand reliability is important in a year-round continuous-flow system like this, where compressor failure cannot be tolerated.

Ingersoll-Rand gas-engine compressors are built in sizes from 110 to 2000 hp, for any gas, any pressure. If you have a compressor problem, call your nearby I-R representative. He is always ready to give valuable help.

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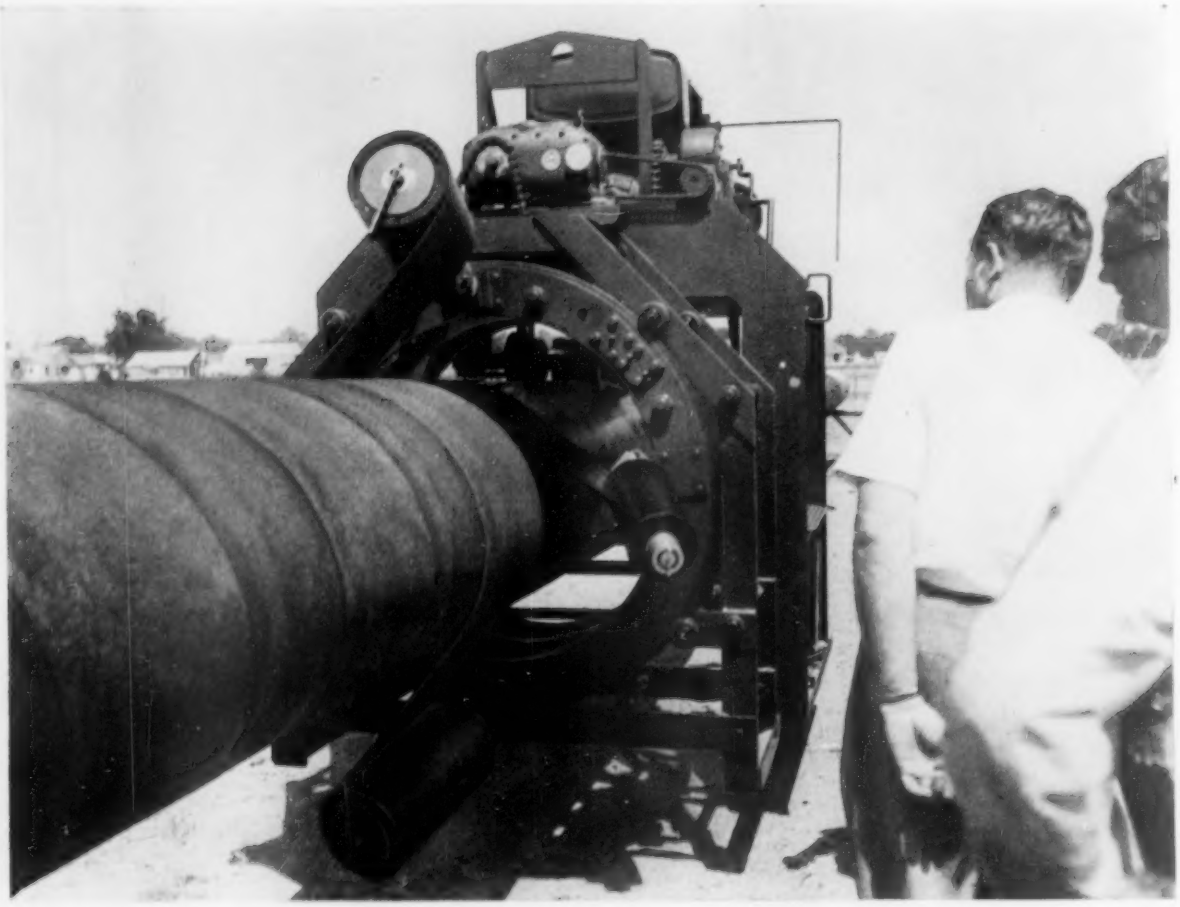

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●●●	●●	●●	□●●	●●	●●●		●●	●●●	●●	●●	●●	●●●	Precision Mechanics, Optical Devices, Ceramics
●●●	●	●			●●●		●●●	●●	●	●●	●	●●●	Electrical Equipment and Components
●●●	●●	●●●	●●●		●●●		●	●●		●●●	●●	●●●	Electronics
	●●			●●●		●●●				●●●			Hydraulics, Liquids Processing, Heat Exchange
●	●		●●●		●					●			Television: Studio, Theatre, Business, Institutional, Industrial
●●●	●	●●	□●●		●●●	●●●	●●	●●		●●●	●	●●●	Instruments, Servos, Controls: Hydraulic, Pneumatic, Magnetic, Electronic
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	●●●		□●●				●●	●●●	●●●		●●●		Motion Picture and Audio Equipment
●●●				●●						●●		●●●	Nuclear Power Components and Controls
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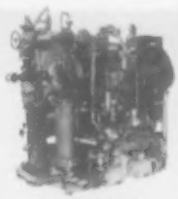

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No GPE company is limited by the boundaries of its own specialties. The basic GPE operating policy, GPE Coordinated Precision Technology, places at the command of each company in the group all GPE research, development and production facilities, and the skills and experience of the more than 2500 GPE technical men working in depth in the wide range of advanced capacities indicated in the chart above.

Behind each group working on a specific problem in one GPE company stands the whole group of GPE scientists, engineers and technicians with the answers — or the knowledge that will find the answers — to questions underlying and related to that problem. To the customers of GPE Companies this means that the concept and development of equipment, components and systems are not restricted or distorted by traditional allegiance to specific competences.

The five systems illustrated, while products of different GPE companies, are all examples of the consistent application of balanced competences, achieved through GPE coordination. For brochure describing GPE Coordinated Precision Technology and the work of the GPE Companies, or help on a specific problem, write: General Precision Equipment Corporation, 92 Gold Street, New York 38, N. Y.

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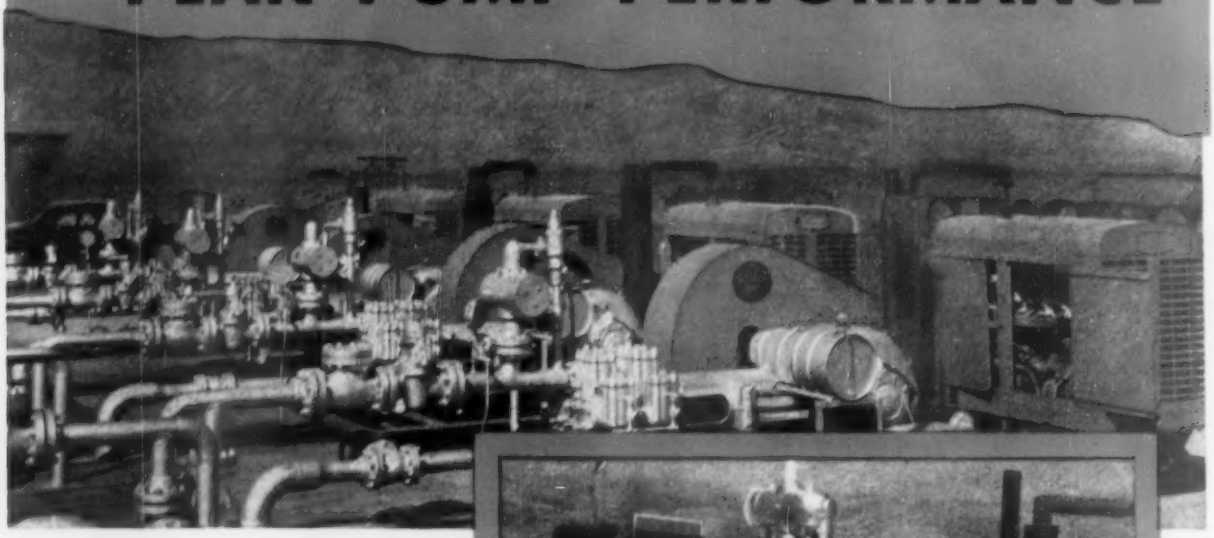

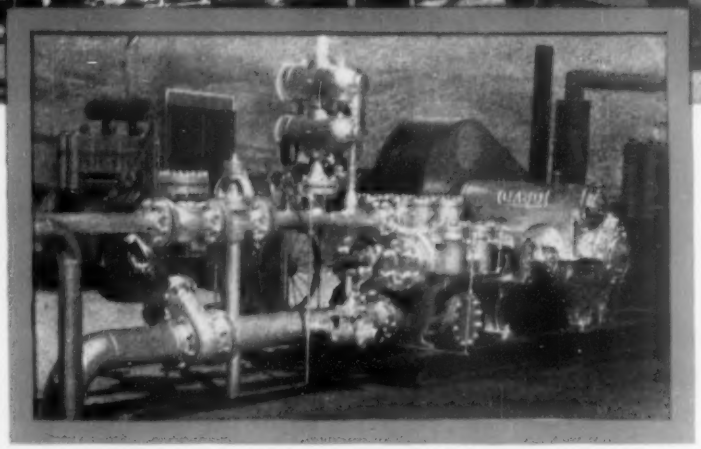

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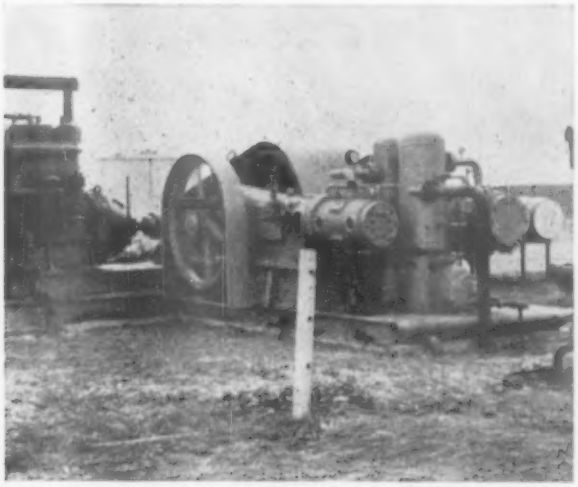
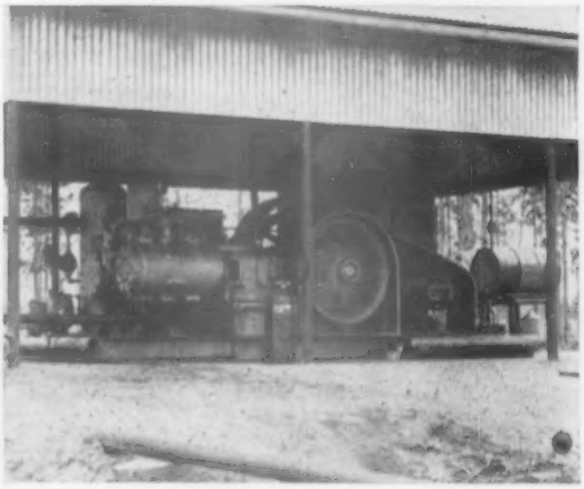
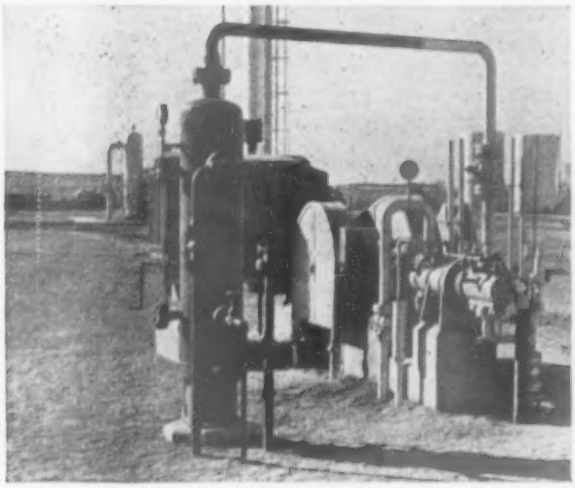


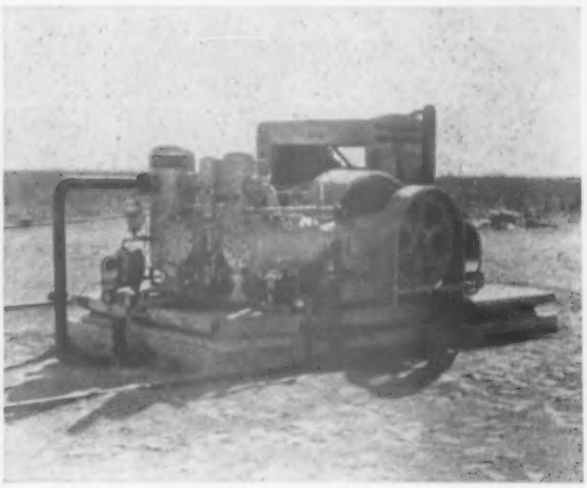
Repressuring



Bucking line pressure



Field processing



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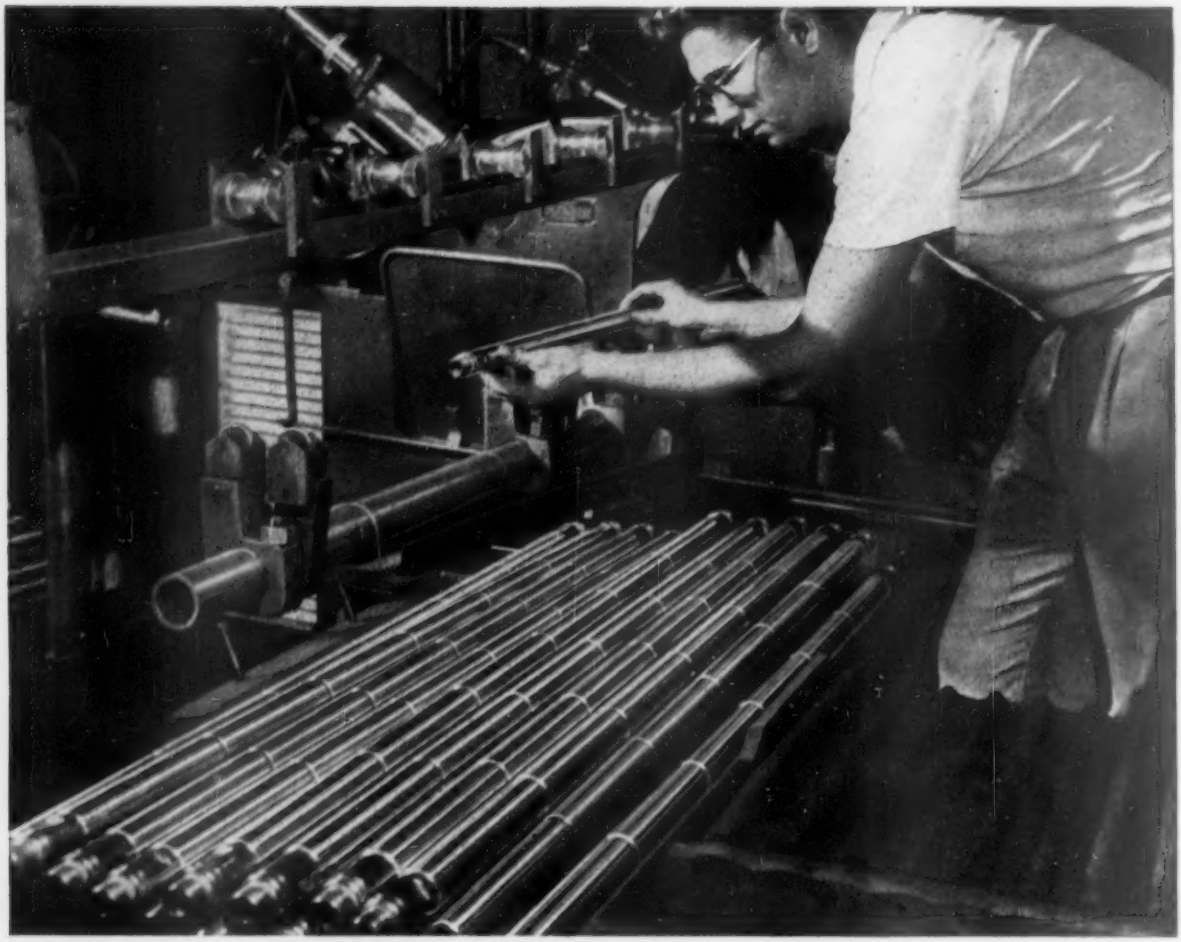

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Like so many products, the deep well reciprocating pump manufactured by Fluid Packed Pump Company of Los Nietos, California, is practically all tubing with the exception of fittings used on the end. And because the pump's components are received as tubes—semi-finished products in themselves—they require much less fabrication than would otherwise be necessary.

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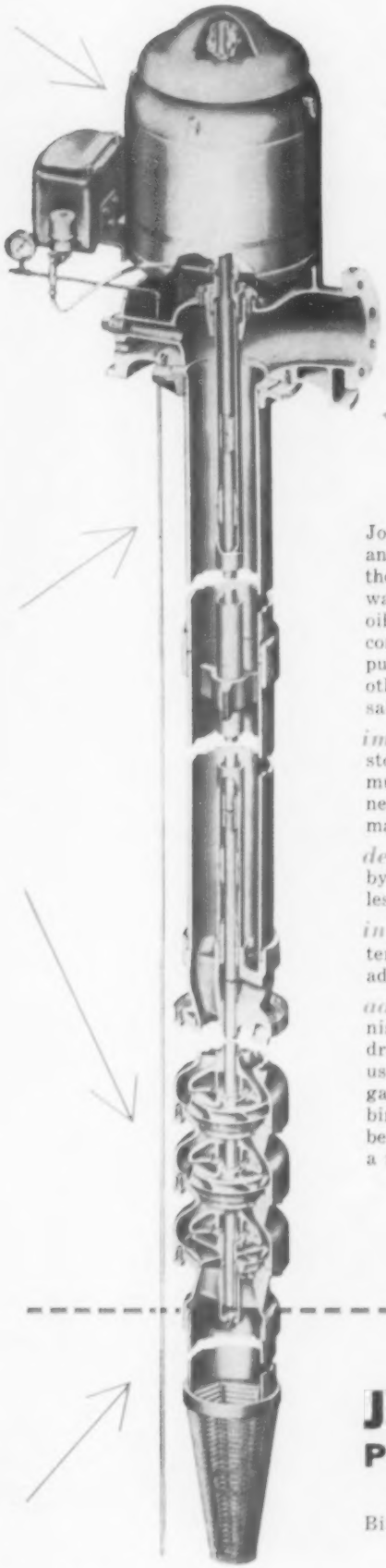
A closer look at your own product, from both a design and fabrication standpoint, may reveal opportunities for tubing applications that may save time and money and improve your product. Whatever your requirements, B&W Tubing—carbon, alloy or stainless—can meet them. Call Mr. Tubes, or write for Technical Bulletin 365. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-5024M

Seamless and welded tubular products, seamless welding fittings and flanges—in carbon, alloy and stainless steels



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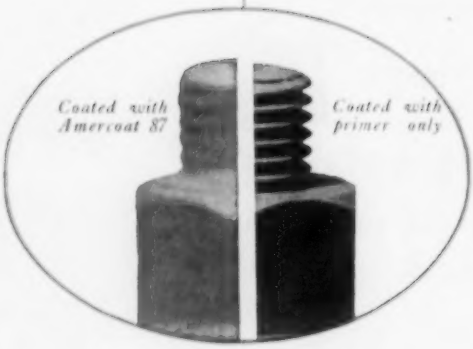

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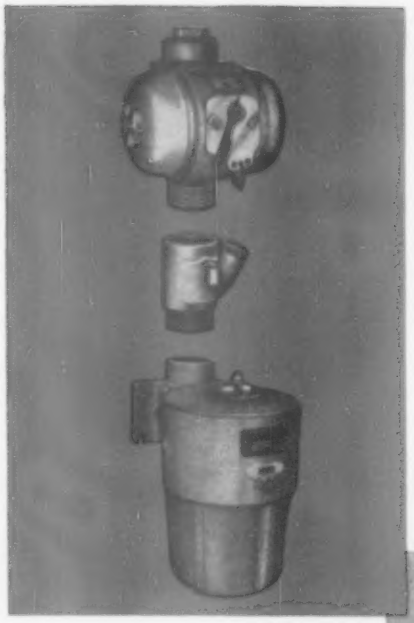

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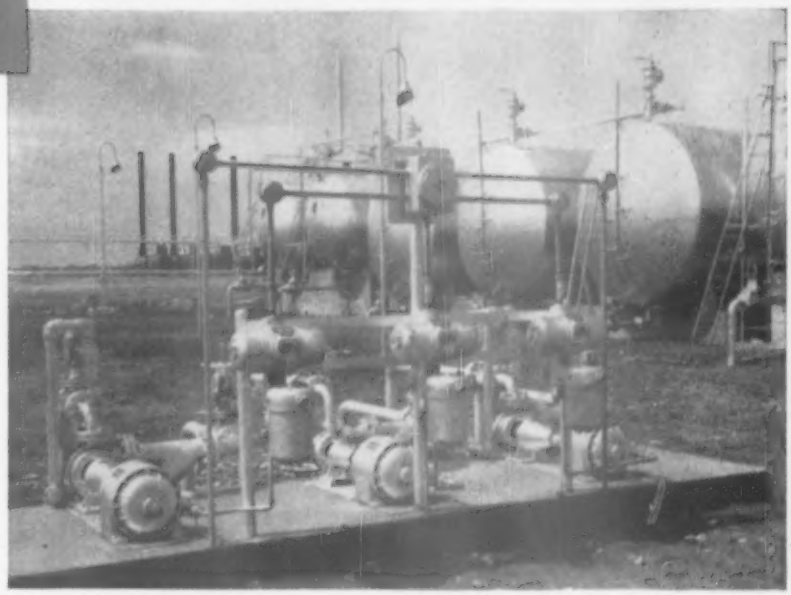

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APPLETON Circuit Breaker and Motor Starter Unilets on tank car loading pump motors in field processing plant.

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"At Oil Production Maintenance Company's rig N-75," says "Red", "toolpusher Lefty Wood swears by U. S. Rainbow® V-Belts. The belts (U. S. Rainbow D540) worked steadily on a Wilson-Snyder pump for 2 years, and just wouldn't wear out or go haywire."

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Wickwire Rope distributors are men who wear many hats. They are at home in the headgear typical of the numerous and varied industries they serve—the marine and fishing trades, the oil fields, construction, logging and many other industries having specialized wire rope needs.

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Yes, your Wickwire Rope distributor is a good man to know. He's quality people handling quality products. Buy your wire rope and wire rope slings from him. You'll find that the many valuable services he offers far outweigh any apparent price advantage you might gain by buying direct.

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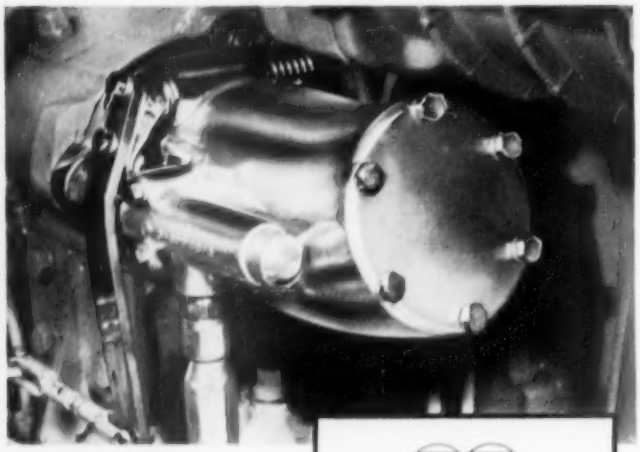
It takes a forest giant

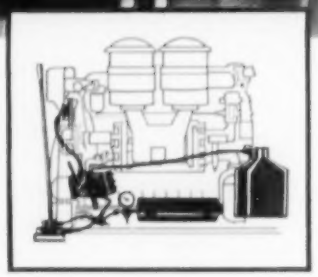
10 seconds to fall

But a Hydrostarter starts a GM Detroit Diesel in

Only a split-second



Heart of the Hydrostarter is this hydraulic starting motor. Other components are an engine-driven pump, accumulator, emergency hand pump and reservoir.



15/100 of a second is a mighty short time—but that's all the time needed by a Hydrostarter to start a General Motors Detroit Diesel. And a Hydrostarter costs less to maintain than regular starting systems, costs less to buy than any other nonelectric diesel starter. What's more, a Hydrostarter can last a lifetime—as proved by a record 26,788 starts in a recent 26-day test. For fast, sure starts even at 20° below, order a Hydrostarter on your next GM Detroit Diesel—or have one installed on your present engine. See your GM Detroit Diesel distributor or dealer for more information or write direct.

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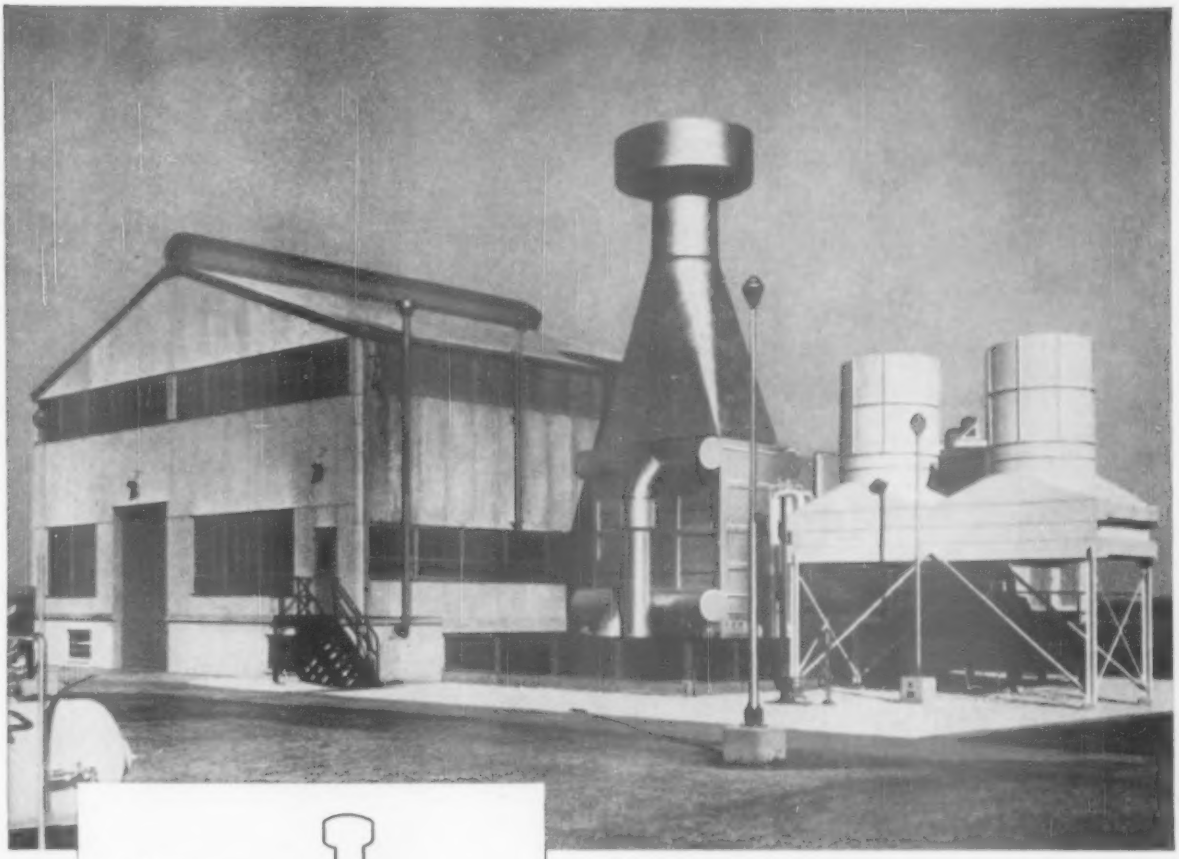
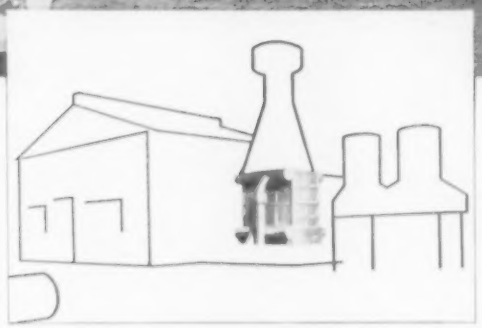
Single Engines . . . 30 to 300 H.P. Multiple Units . . . Up to 893 H.P.

AMERICA'S LARGEST BUILDER OF DIESEL ENGINES





This is the Trunkline Gas Company's Edna Compressor Station with a Pin-Fin installed. Note the compactness of this regenerator.

* Specially designed "pin-like" shapes, which project inside the heat transfer core, give the new Air Preheater Pin-Fin its name. Their unique, patented design greatly extends heat-transfer surface area.

New Pin-Fin users are:

Tennessee Gas Transmission Co.	1 unit
Trunkline Gas Co.	3 units
Texas Eastern Transmission Corp.	6 units

NOW...economy in gas-turbine cycles with Air Preheater's new Pin-Fin* Regenerator

To compete commercially with Diesel engine steam-turbine and gas-engine cycles, a gas turbine must normally include a heat exchanger. And the most efficient unit for this service is Air Preheater's Pin-Fin—the new, extended-surface heat exchanger.

For example, a 75%-effectiveness Pin-Fin Regenerator in a gas-turbine cycle at 6-to-1 pressure ratio and a turbine inlet of 1500°F. will reduce fuel consumption by approximately 32%.

Air Preheater Pin-Fin Regenerators have been in service up to five years with no major maintenance problems. For details, call or write the Air Preheater Corporation.

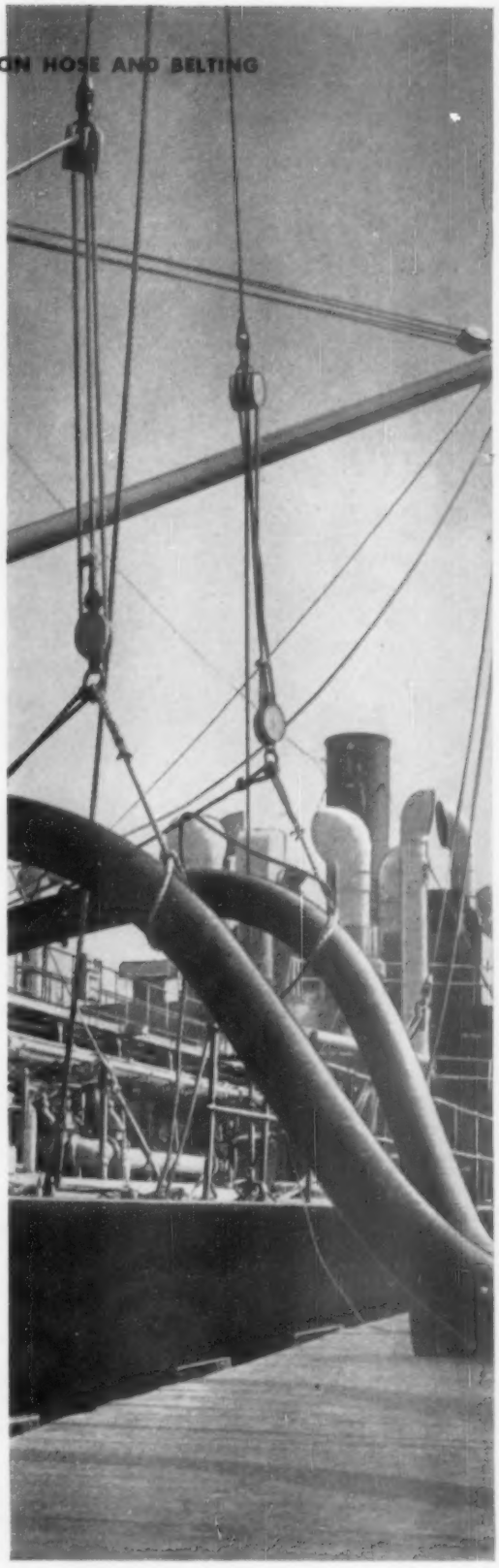
MECHANICAL ADVANTAGES OF THE PIN-FIN

- Compact
- Lightweight
- Quickly erected
- Minimum maintenance
- Convenient, one-unit design
- Readily disassembled

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

READ WHY SO MANY ENGINEERS AND FIELD MEN SPECIFY BOSTON HOSE AND BELTING

How to slash handling costs and downtime right now!



FROM THE MOMENT SPUDDING STARTS until the end product reaches the consumer, breakdowns chop profits and waste time. To avoid these headaches, many engineers specify Boston hose and belting. They've discovered Boston products handle the toughest jobs—turn in reliable performance on every job.

BUT THAT'S ONLY NATURAL! Boston *specializes* in rubber products for industrial use. And because it isn't just a sideline, Boston has only one aim: to continue developing products that dollar-for-dollar outperform all others.

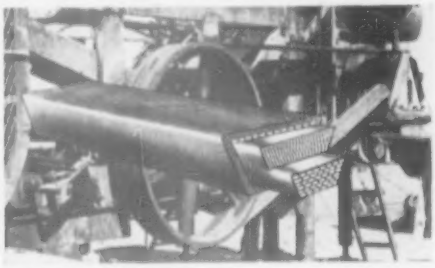
FAST DELIVERY WHEN YOU NEED IT, is next in importance after good performance. Your Boston distributor knows that. He keeps a supply of Boston hose and belting ready to meet your needs. And he knows your problems as well as he knows industrial rubber products. That's why he's your Boston Man! Call him today.

BOSTON HEAVY DUTY OIL HOSE: For loading and unloading tankers and barges. Boston has a full line of oil suction and discharge hose—all time-tested, proved sturdy. Boston hose is furnished with built-in steel or duralumin nipples. Get full details from your Boston Man.

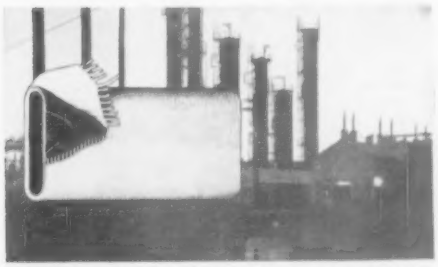
INDUSTRIAL HOSE · FIRE HOSE · BELTING

BOSTON CHECKLIST FOR YOUR HOSE AND BELTING REQUIREMENTS

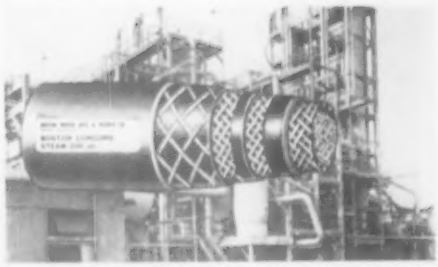
BOSTON TANK TRUCK AND FUEL OIL HOSE: Boston's seamless, synthetic tube won't flake or soften because it is unaffected by gasoline, oil, and other fuels. That means more rapid fuel transfer under all conditions. Your Boston Man will help you select the right hose for your jobs.



BOSTON V-BELTS: Muscles of tough, special cord brace *all* Boston V-Belts against slippage and shock loads. That's why they require less maintenance than other belts, deliver power more smoothly, efficiently and economically. Get the right belt for your job from your Boston Man.



BOSTON CHEMICAL AND FIRE HOSE: Boston's complete line of chemical and fire hose lasts longer even under the toughest conditions. That's because every Boston hose is designed for a specific job, engineered to do that job more effectively. Put Boston hose to work to protect your plant!



BOSTON STEAM HOSE: Built with safety to spare, Boston Steam Hose eliminates breakdowns and handling problems on cleaning and maintenance jobs; Boston's complete line of wire-reinforced and wrapped fabric steam hose is made with time-tested, heat-resistant compounds.

BOSTON SERVICE STATION HOSE: Air hose and gasoline Curb Pump hose used in service stations must absorb rough handling, weather, dirt, grease. Boston hose is designed to take this kind of punishment. There's a full line of Boston maintenance hose for air, water and steam applications.

BOSTON *Specialists*

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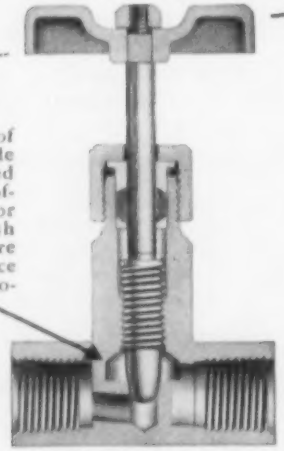
MAXIMUM WORKING PRESSURE
10,000 PSI
for water, oil or gas

- Body and stem guide extra heavy bar stock fused into one piece.
- Valve stem 416 stainless steel.
- Packing special one-piece "Marpak" moulded ring.
- Bodies marked in accordance with MSS regulations.

ONE PIECE

The stem guides of conventional needle valves are screwed into bodies—this often causes leakage or blow-outs. Marsh Needle Valves are fused into one-piece by exclusive "Conoweld" process.



The Ultimate in Needle Valves

Here is one of the crowning achievements of Marsh research, design, and manufacturing skill. It is the first needle throttling and shutoff valve to combine *all* of the qualities called for today in this highly critical and ever broadening field.

It is a valve that has strength and safety to spare . . . rated for pressures up to 10,000 psi—equally efficient in the lower ranges. A product of Marsh instrument-making and valve manufacturing experience, it combines instrument-like precision with the ruggedness that distinguishes all Marsh valve specialties.

The illustrations tell the story of new thinking; new standards. Body and stem-guide are machined from extra-heavy carbon steel bar stock. Still greater strength and rigidity are achieved by fusing the stem-guide into the body. The complete fusion of guide and body is accomplished by the exclusive Marsh "Conoweld" process.

There are two big advantages to this one-piece construction: (1) It eliminates the danger of unscrewing the valve from the body when opening—a frequent cause of leakage, even dangerous blow-outs (2) It permits perfect line-up of threads and seat. As a result, Marsh valves are easier to operate even at high pressures.

The precision-machined stem is 416 stainless steel. Stem threads are fine pitch for extra strength and fine, controlled regulation. Notable advancements are special "Marpak" one-piece, non-binding longer-lasting packing; deep thread chambers, keeping inlet and outlet piping away from ports and contributing excellent flow characteristics. Entire packing nut and packing gland are electro-zinc plated, preventing corrosion and giving the valve a handsome, plated exterior. The rugged malleable handle is finished in heavy baked enamel.

The new needle valve line includes globe and angle patterns with double female connections in sizes ⅛", ¼", ⅜", ½", ¾" and 1". Also globe and angle valves with male inlet and female outlet in sizes ¼" and ½". *Complete stock carried at our Skokie, Illinois factory and also at our branch plant in Houston, Texas.*

Write today for catalog giving complete details.

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corporation*
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The new 4-wheel drive Oshkosh 50-50 ready-mixed concrete carrier is built to haul up to 5 cubic yards legally, with enough water for ready-mixed concrete operations. Its Continental Red Seal B6427 engine is cantilevered forward of the front wheels, distributing the load equally between the two axles, and making the unit conform to maximum load limits in most states . . . Continental F4162 engine driving the 4½ cu. yd. Rex Adjusta-Wate Moto-Mixer is mounted at rear of the machine, making possible the most efficient load distribution over all axles, for carrying maximum payload.

When it comes to tough jobs, the hauling of ready-mixed concrete ranks well toward the top of the list. It takes a real engine merely to move such a monster as this, to say nothing of lugging it over all sorts of terrain in order to spot the load.

In the oil field, as elsewhere, Continentals have long been known for dependability. Their famous in-built stamina is earning them a place in more and more of today's heavy-duty equipment, not only in transportation but in industry and farming as well. Every Continental Red Seal is built for the job in which you find it—and backed by service and parts facilities coast to coast.

OPPORTUNITIES FOR ENGINEERS
Continental Motors and its subsidiaries have numerous openings for engineering personnel interested in challenging careers in gas turbine and reciprocating engine development. For information, address Engineering Personnel Dept., 12800 Kercheval Ave., Detroit 15, Mich.

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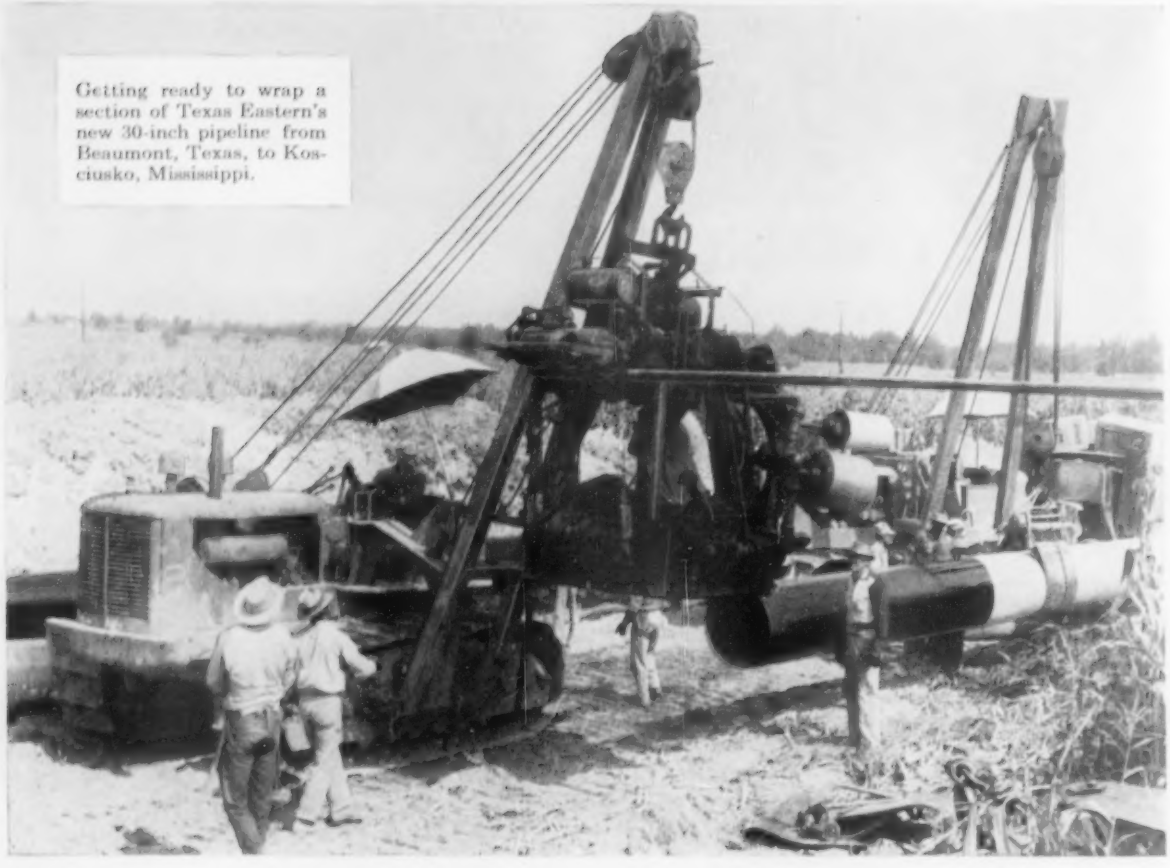
PIPELINE news from L·O·F GLASS FIBERS COMPANY



Getting ready to wrap a section of Texas Eastern's new 30-inch pipeline from Beaumont, Texas, to Kosciusko, Mississippi.

Texas Eastern used Blue Flag to help protect its new 30-inch pipeline

Companies with large pipeline investments know they can rely on L·O·F Glass Fibers' Blue Flag Reinforcing Pipe Wrap. A Blue-Flag-reinforced coating prolongs pipeline life years longer than unreinforced coatings . . . yet costs less than .5% of the original investment!

Here are other reasons why Blue Flag increases application efficiency, helps protect pipelines from corrosion . . .

- High tensile strength virtually eliminates breakage in the field!
- Uniform porosity allows hot enamel to bleed, and trapped gas to escape quickly—keeps "holidays" to a minimum!
- Retards cold flow of the enamel!
- Increases enamel strength!
- Helps protect coating from backfill damage!
- Made of special inert glass which resists action of soil chemicals.

Blue Flag Reinforcing Pipe Wrap is available from strategically located distributor warehouses. For full details, write *L·O·F Glass Fibers Company, Dept. 78-46, 1810 Madison Avenue, Toledo 1, Ohio.*

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BLUE FLAG PIPE WRAP

L·O·F GLASS FIBERS COMPANY
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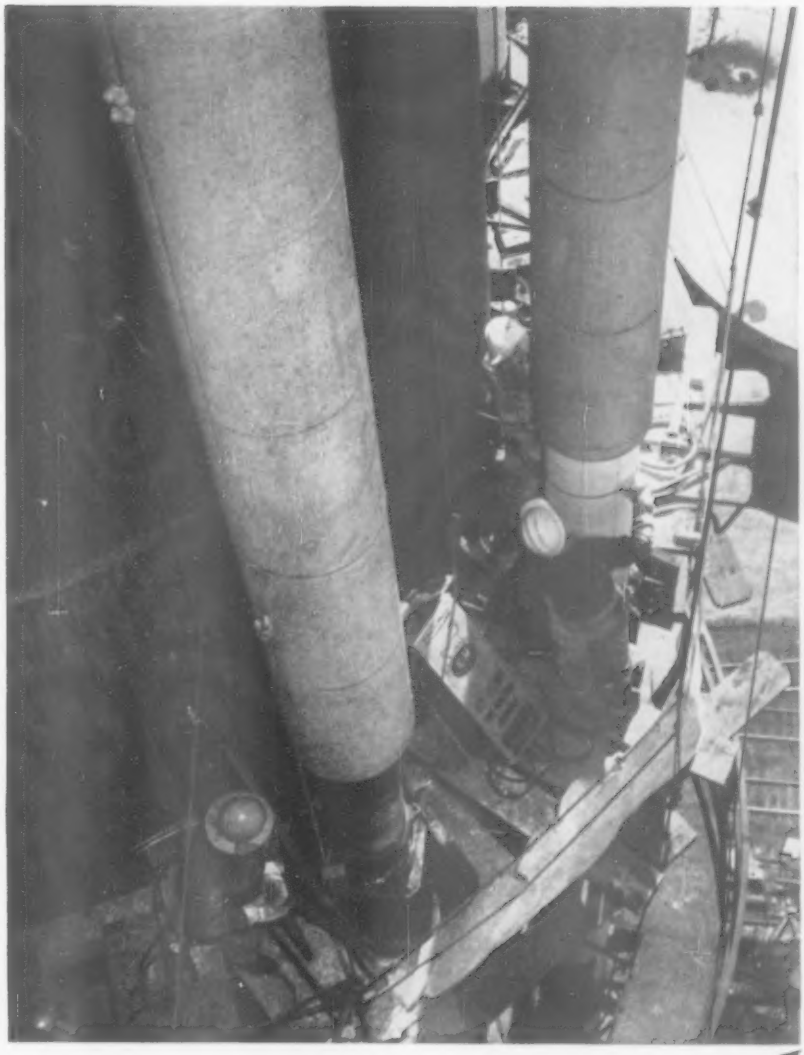
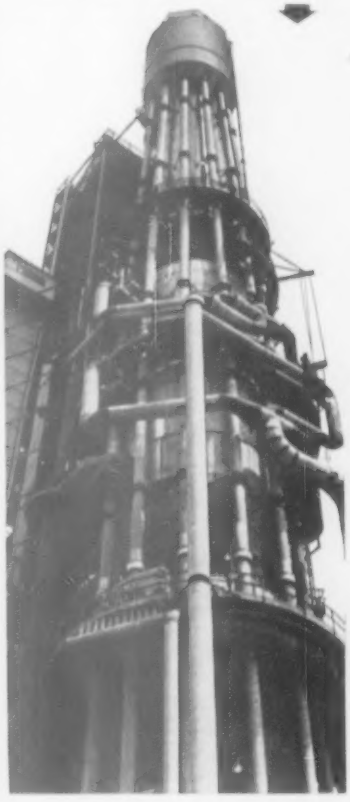
Makers of glass fibers by the exclusive "Electronic-Extrusion" process

For complete pipeline protection, use: BLUE FLAG Reinforcing Pipe Wrap • **DURAMAT** Protective Outer Wrap • **DURAMESH** Pipeline Fabric • **DURATAPE** Pipeline Joint Wrap



The World's Largest Houdriflow, at the Sun Oil Company refinery, Marcus Hook, Pa., is 350 feet high. Lift piping to its reactor tank is insulated with a combination of K&M Hy-Temp and K&M "Featherweight" 85% Magnesia.



Easily Applied, Hy-Temp and "Featherweight" insulations quickly go on 14" lift pipes high above ground. This huge catalytic petroleum cracking unit embodies some 2½ miles of insulated piping. Insulation contractor: Armstrong Cork Company.

K&M Thermal Insulations help keep the world's biggest "cat" purring

It takes plenty of heat to crack petroleum. This king-size catalytic cracking plant ("cat") works 24 hours a day, seven days a week—with operating temperatures as high as 1500°F. K&M Thermal Insulations minimize heat loss and keep heat on the job here, just as they do in power plants, factories, and institutions the country over.

K&M "Featherweight" 85% Magnesia and Hy-Temp Insulations withstand moisture, vibration, frequent temperature changes. For efficiency to 1900°F., these insulations are applied in combination, with staggered joints. This eliminates heat loss that normally occurs in single-layer installations when expansion causes joints to open. "Featherweight" is efficient to 600°F. when used solely.

Plan your new plant with these heat-saving, cost-saving insulations in mind. Bring your present plant up to date with K&M Thermal Insulations. Contact your K&M distributor, an experienced applicator, for full details. Or write directly to us.

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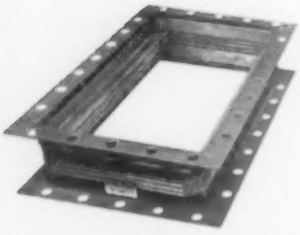
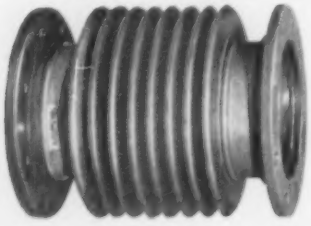
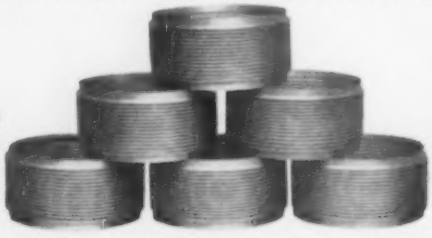
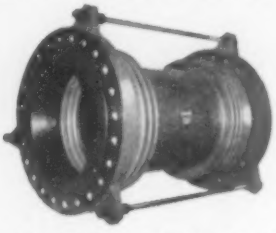
K&M best in asbestos

Sola-Flex bellows 



and expansion joints

are made  in all sizes

and varieties 

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BIG OR LITTLE, round or square, convoluted or U-span—no matter what kind of expansion joints you need, Solar can build them. Sola-Flex joints are durable, economical, and are based on advanced engineering designs using a wide variety of metals. High or low pressure piping problems are easily solved with Sola-Flex bellows. Ask for our latest catalog. Write Dept. B-143, Solar Aircraft Company, San Diego 12, Calif.

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When You Use MIDWEST "LONG TANGENT" ELBOWS

ADVANTAGES OF MIDWEST "LONG TANGENT" ELBOWS

- ★ They save pipe.
- ★ They often eliminate short nipples and their extra welds.
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- ★ They make it easier to apply slip-on flanges.
- ★ They remove the circumferential weld from point of maximum stress and can be sleeved.
- ★ THEY COST NO MORE THAN OTHER ELBOWS.

The long tangents available *only* on Midwest Welding Elbows give you *more fitting for the same price* . . . Midwest "Long Tangent" Elbows cost no more than other elbows. This added length has numerous advantages for the user of welded piping . . . advantages that save money and improve piping. For all the facts, ask the nearest Midwest distributor or write us for Catalog 54.

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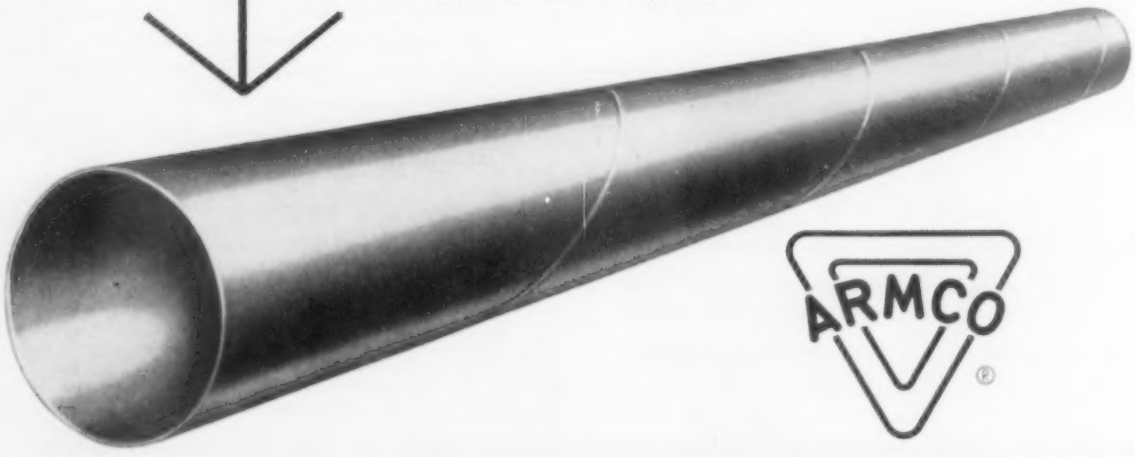
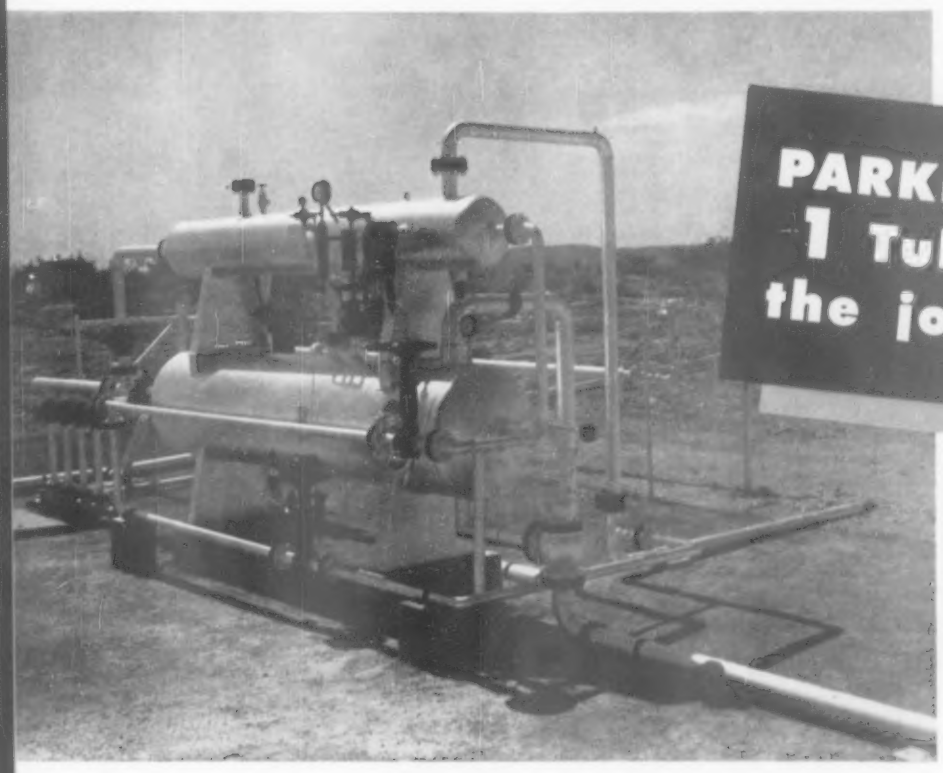
You select the right wall thicknesses for the job without buying costly and useless extra metal.

Use Armco Welded Steel Pipe for requirements in the Natural Gasoline and Natural Gas Divisions and wherever else you need dependable line pipe. Write for more data. Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division, 4396 Curtis Street, Middletown, Ohio. 201 KOME Building, Tulsa, Oklahoma. Subsidiary of Armco Steel Corporation. Export: The Armco International Corporation.



ARMCO®

why buy 2 tube separators when



Two-stage separation is a perfect example of the advantages offered by Parkersburg single tube horizontal separators.

How? A standard high pressure horizontal separator—without water legs, drip pots or second vessels—can be saddled on top of a standard low pressure horizontal separator to give you the most efficient two-stage unitized separator you can buy. And when needed, you can use either separator individually simply by breaking down the assembly.

Easy to install, these units have all the outstanding performance features of Parkersburg's famous horizontal separators: 20% greater interface area for de-gassing; 20% slower gas flow for more effective natural separation; longer retention of more gaseous liquids; incoming fluid broken into largest possible droplets; all entrained liquid removed from gas stream; liquid level maintained by No-Bleed Level Controller.

• *Ask your Parkersburg representative how Parkersburg's Two-Stage Separators save you money by giving you dual service.*

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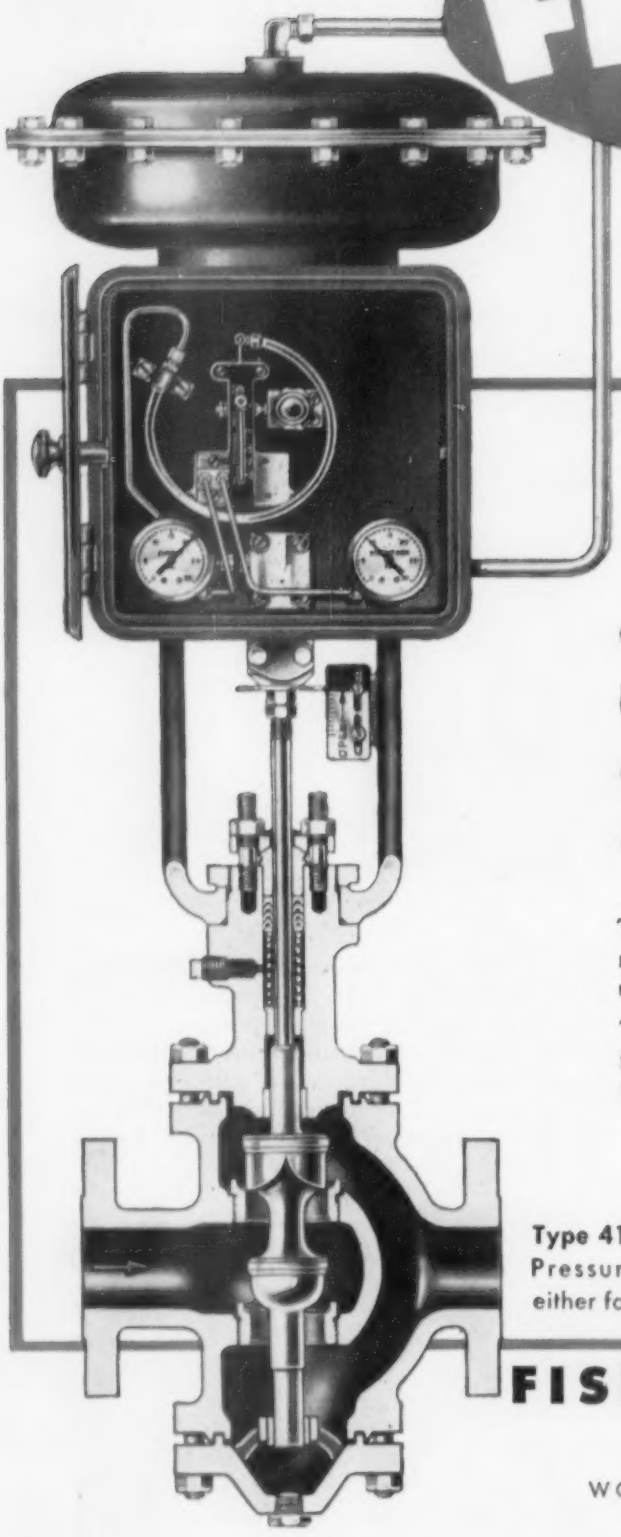

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The acknowledged favorite for all of the roughest pressure conditions in the gas transmission field.

This is the equipment you see in the finest border stations and on the major pipelines all over the world.

Type 4100U—657A Wizard
Pressure Controller—available either fail open or fail close action.

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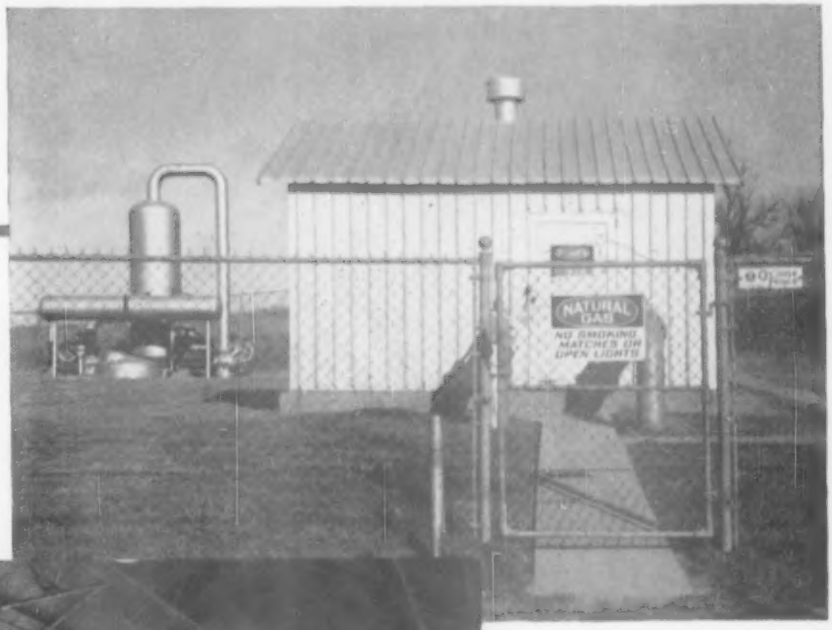
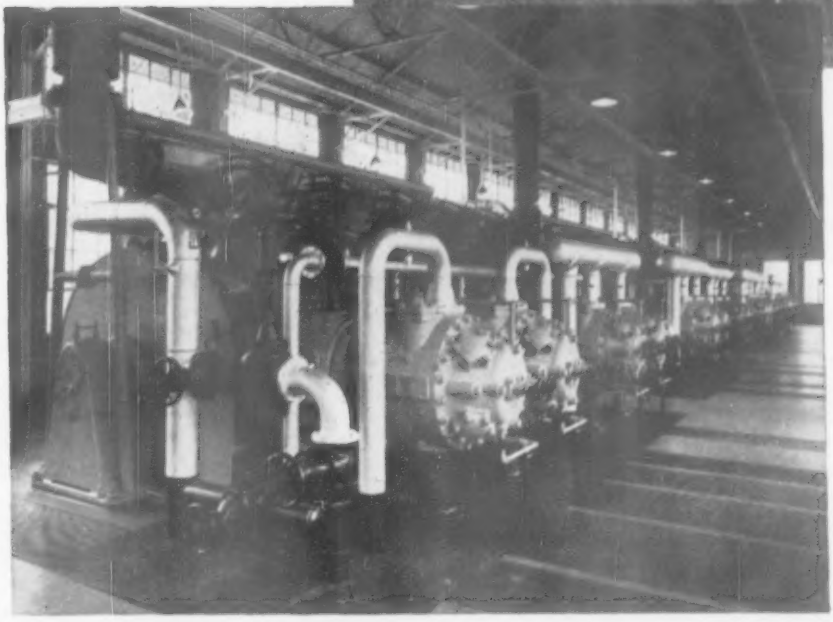


A TYPICAL MIDWESTERN CITY BORDER STATION



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COMPANY · MARSHALLTOWN, IOWA

CANADIAN PLANT: WOODSTOCK, ONTARIO

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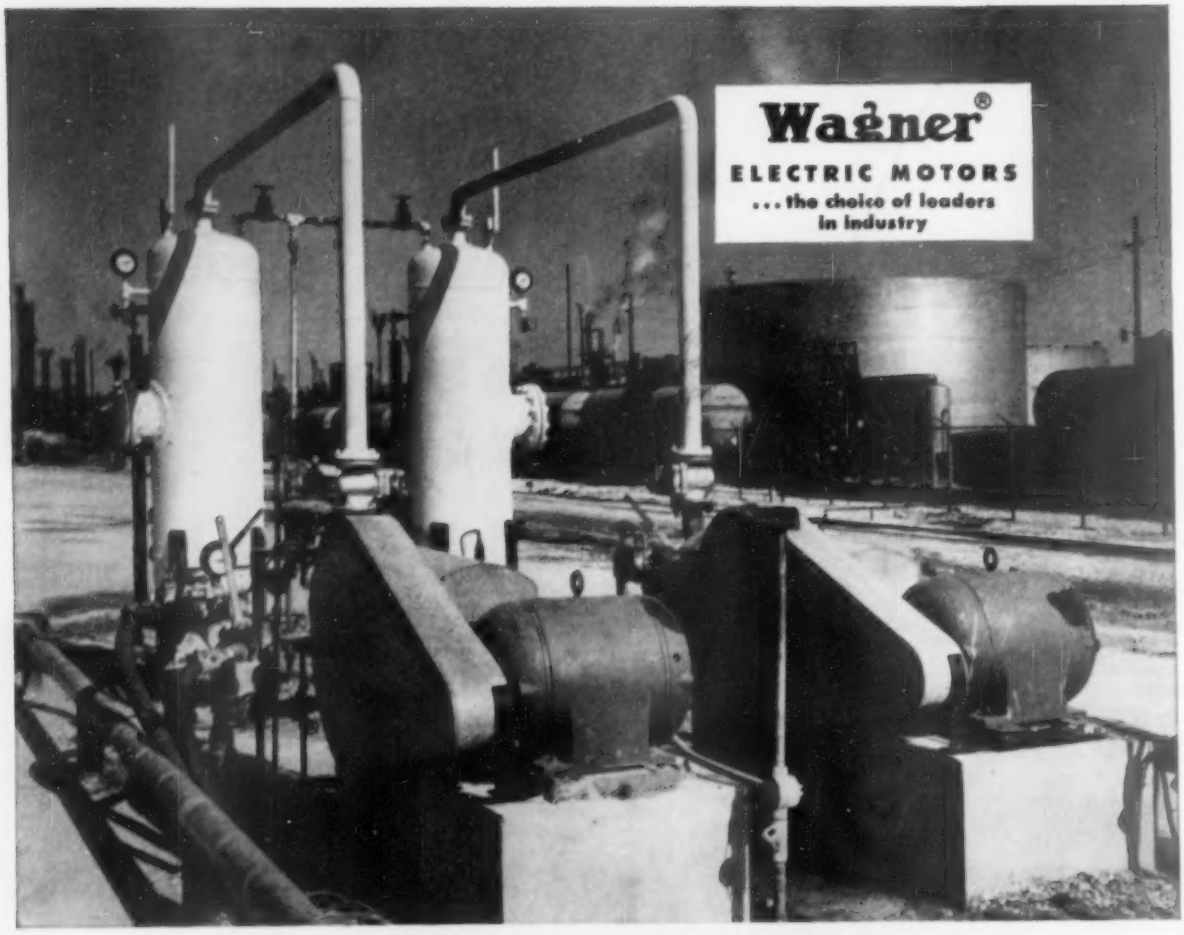


Protected against explosion

WAGNER JP MOTORS

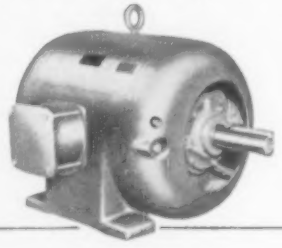
A single spark in a hazardous atmosphere can mean the end of refinery production . . . to say nothing of possible loss of life and millions of dollars in damage from fire and explosion.

Wagner Type JP Explosion-Proof Motors are expressly built for applications in hazardous atmospheres. They're perfect for the job . . . that's why they're the time-tested favorites of the petroleum industry—in pumping stations and in refineries. They are approved by Underwriters' Laboratories for Class 1 Group D hazardous locations. These motors are available in a complete range of ratings through 250 hp, normal torque and high torque.

In addition to these explosion-proof motors, Wagner also manufactures a line of drip-proof 40°C. polyphase motors, in ratings through 75 hp, especially designed for the continuous outdoor service demanded by oil well pumping applications. High power factor type capacitor oil well pumping motors are available for use where single-phase motors are required.

Write for Bulletin MU-132 on Cast Iron Frame Motors and for Bulletin MU-137 on Oil Well Pumping Motors. Thirty-two branch offices are ready to assist you in any motor application problem.

This Wagner Type JP Explosion-Proof, cast iron motor, with frames and endplates of cast iron, is suitable for indoor or outdoor use and for installations where corrosion is a problem . . . as well as for general applications.



Wagner Electric Corporation
EST. 1891

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6389 Plymouth Ave., St. Louis 14, Mo., U.S.A.

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How to make any water* pure

for DRINKING • PROCESSING • DRILLING MUD MAKE-UP

WASTE HEAT EVAPORATORS are particularly adaptable to offshore drilling platforms, tenders and diesel barges. Practically no scale removal. Potable water is produced from the sea at zero cost because unit uses waste heat from rig's diesel engines . . . transmitting it through heat exchangers charged with sea water. Hot water flashed into a vacuum chamber is partially converted into steam, which is then condensed on cooling coils for the output of distilled water for "mud" make-up, drinking, etc. Unit above has a capacity of 300 gph — larger capacities to your specifications.

Investigate the diversified types of Cleaver-Brooks evaporators — engineered for greatest heat and power economies

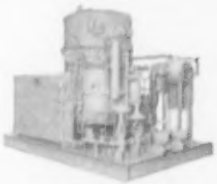
The broadened line of Cleaver-Brooks evaporation equipment now includes types for a wide variety of operating conditions—and to answer *any* need for pure potable water or high quality process water.

- Sea water, brackish water or polluted streams may be used as a prime source, thus eliminating independent pipe lines, trucking or barging.
- Distillate is uniform in quality — regardless of raw water source.
- Evaporators are completely packaged, delivered insulated and fully assembled, ready to receive supply and discharge lines.
- Stationary or mobile units operate independently and automatically after initial starting.

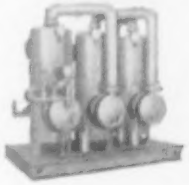
Cleaver-Brooks is highly qualified to design and fabricate evaporators (including special heat exchangers) to your specifications. For complete details, write: Cleaver-Brooks Company, Special Products Division, Dept. D, 376 E. Keefe Ave., Milwaukee 12, Wis., U.S.A., Cable Address: CLEBRO—Milwaukee—all codes.

FLASH-TYPE EVAPORATOR—Combination of four (4) 50,000 gallons-per-day evaporators with a total distilled water capacity of 200,000 gallons per day. Unit will provide entire water supply for super carrier of the U.S.S. Forrestal class. Low-pressure steam is bled from propulsion turbines.

VAPOR COMPRESSION EVAPORATOR (Model S300 DO) — Provides pure water at approximately one-half the cost of other methods. Specially suited for tankers and other bulk-cargo vessels. Distilled water capacity—300 gallons per hour.



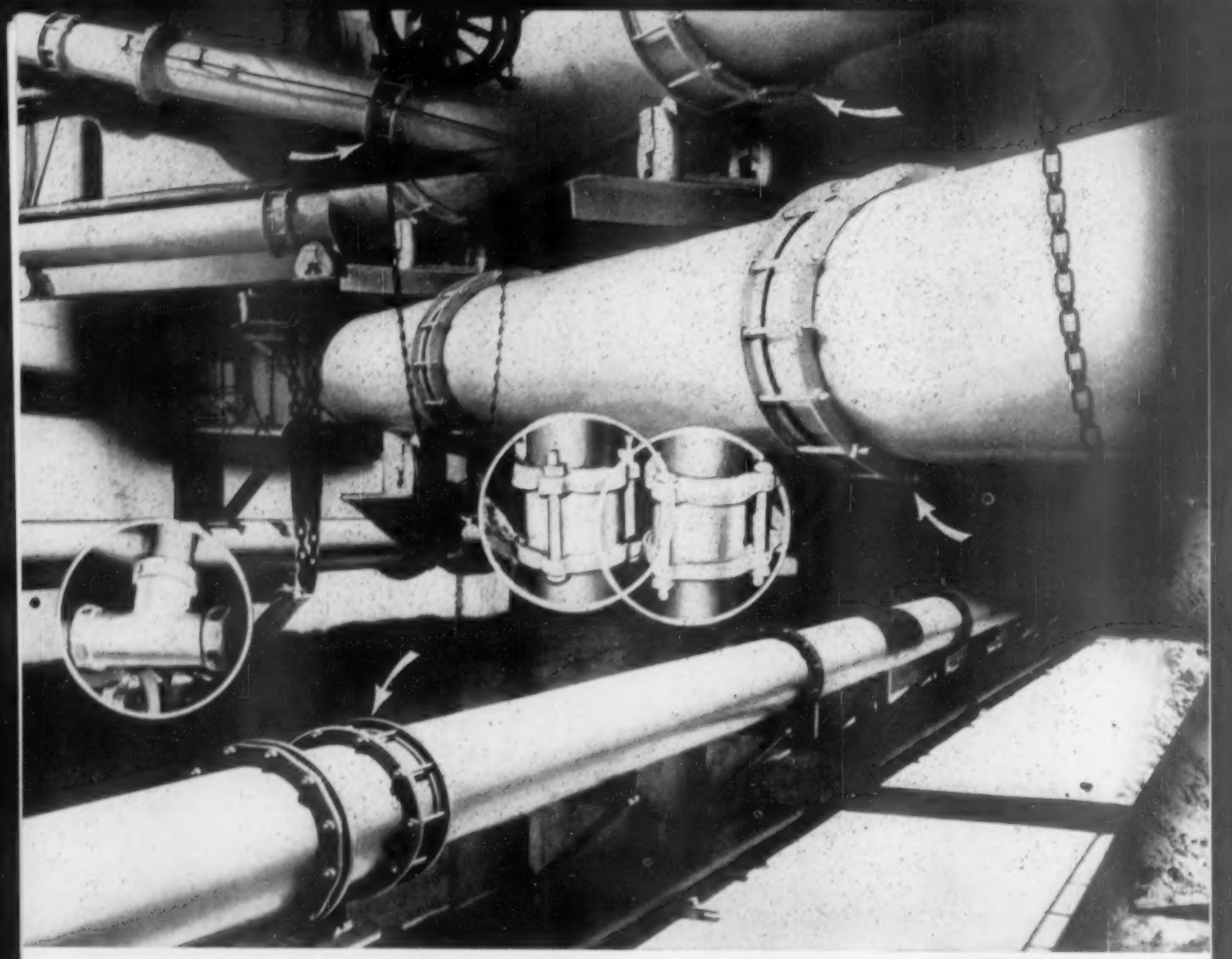
TRIPLE-EFFECT EVAPORATOR (Model F200 TE) — Exceptional economy where sufficient quantities of inexpensive low-pressure steam is readily available. Will produce 200 gallons per hour from softened city water supply.



Cleaver Brooks®

25th YEAR

BUILDERS OF EQUIPMENT FOR THE GENERATION AND UTILIZATION OF HEAT AND POWER



IDECO

IDECO, Dallas, Tex.—Hydrair and Power Rigs; Full-View Masts, Substructures; Single, Dual and Drive-In Rambler Rigs; Blocks, Swivels, Rotaries; Mud Pumps; Petroleum Equipment and Supplies.

Magcobar.

MAGNET COVE BARIUM CORP., Houston, Tex.—Magcobar and Magcogel drilling muds and other specialized oil well drilling fluids and chemicals.

Security

SECURITY ENGINEERING DIVISION, Dallas, Tex., Whittier, Calif. — Rock bits, reamer rock bits and hole openers; reamers, casing scrapers and Neo-Red rubber stabilizers.

CLARK

CLARK BROS. CO., Olean, New York—Gas turbines, engines, and reciprocating, centrifugal and axial flow compressors — gas, steam, electric and diesel driven.

DRESSER
MANUFACTURING
DIVISION

plus products for every industry

For more than 75 years Dresser has been the leader in the design and manufacture of flexible pipe couplings and repair devices of the highest quality. Dresser products are used by every gas utility in the country; for scores of applications in water supply and distribution systems, and in every industry – petroleum, refining, chemical, marine, railroad, and many others. Practically *everywhere* pipe of any size is joined or repaired there is a Dresser coupling, repair clamp, or repair sleeve to speed and simplify the job. Continuous research and development, plus Dresser's long-standing reputation for reliable, carefully-engineered and constructed equipment assure you of the right device for every pipe joining and repair problem.

How the DRESSER *plus*+ works...

In every industry, Dresser flexible couplings and pipe fittings are teamed with other Dresser equipment – engines, pumps, compressors, blowers, steel products, and oil production equipment – to assure the Dresser *Plus*+ in thousands of applications.

Dresser flexible couplings hold fast more than 500,000 miles of pipe for gas pipe line companies and gas and water utilities throughout the world. In the oil industry, they connect gathering, flow, mud, and salt water lines, and are used for such exacting applications as high-pressure transmission lines. The largest coupling ever made – an 18-foot Dresser flexible coupling – joins a penstock for one of the nation's huge hydro-electric power plants.

The extra quality of design and construction in Dresser couplings and fittings is another example of the Dresser *Plus*+ in action. This is the extra value you get from the combined experience, research, engineering facilities and resources of *all* the Dresser companies. This outstanding inter-company teamwork provides Dresser Plus+ equipment and services . . . the standard of comparison the world over!

ROOTS-CONNERSVILLE BLOWER DIVISION, Connersville, Ind.—Rotary positive blowers, gas pumps, centrifugal blowers, exhausters, and positive displacement meters.

LANE-WELLS CO., Los Angeles, Calif., Houston, Tex., Oklahoma City, Okla.—Electric and Radioactivity Well Logging, Koneshot perforating and bullet perforating, packers and bridging plugs.

DRESSER-IDECO DIVISION, Columbus, Ohio – Radio and television broadcasting towers, steel buildings, aircraft hangars, mechanical parking garages, electric power substations.

PACIFIC PUMPS, INC., Huntington Park, Calif. – Centrifugal pumps for refineries, power stations, pipelines, and chemical plants; plunger pumps for oilwells.

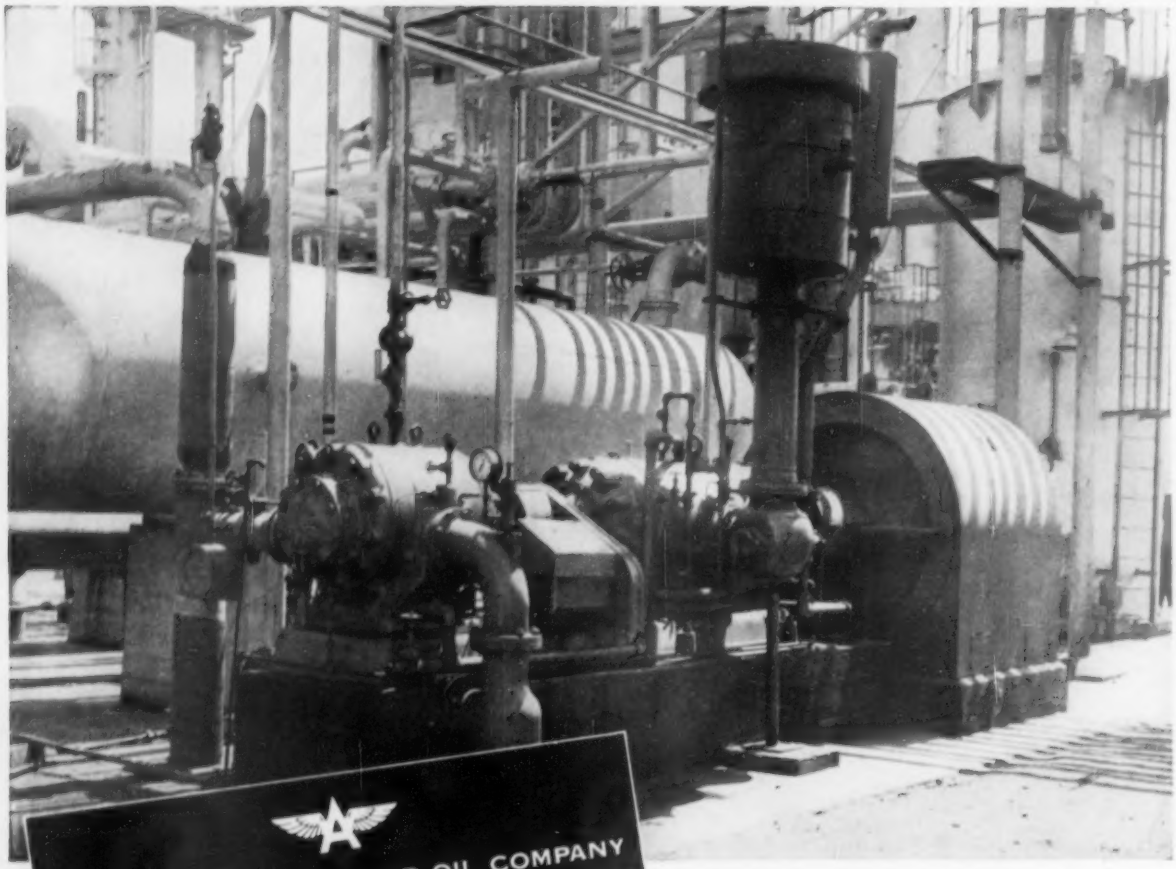
SOUTHWESTERN INDUSTRIAL ELECTRONICS, Houston, Tex.—Seismograph systems and instruments—electronic, electro-mechanical. Computers—analog and digital; recording systems. Special transformers, reactors.

put the Dresser plus+ to work for you!

DRESSER INDUSTRIES, INC.

OIL, GAS, CHEMICAL AND ELECTRONIC EQUIPMENT AND SERVICES

REPUBLIC NATIONAL BANK BUILDING • POST OFFICE BOX 718 • DALLAS 21, TEXAS



installs fuller rotary compressors in its Avon Refinery

When Tide Water Associated needed additional air for various operations in its Avon plant, its engineers investigated the possibilities of the Fuller Rotary Compressor. After making a thorough study of its merits, Tide Water purchased and installed two C-300-300H two-stage units, each supplying 1598 c.f.m., 100-lb. air for general plant use, one of which is shown above. Note that this machine is installed out in the open with no protection from varying weather conditions, operating 24 hours per day, seven days a week.

These two-stage machines are located in different departments of the plant to best meet the air-load requirements of the particular department being served.

Tide Water also has installed in this same plant, two C-300 Fuller Rotary single-stage compressors with a capacity of 1542 c.f.m. each, at 40-lb. pressure, used in the catalyst-cracking process.

Hundreds of Fuller Rotaries are serving the petroleum industry, proving their worth for general plant air, purging gas, refrigeration in alkalization units, and handling butane-butylene in the refinery, as well as in the field for pressure boosting and gas gathering.

Simplicity of construction has proved to be one of the important factors—no valves to leak, no seats to grind, results in maintained capacity for the life of the machine; simplified drive eliminates power transmission losses. For full information write us for Bulletin C-5A.

FULLER COMPANY
GENERAL AMERICAN

Fuller
. . . . pioneers in harnessing AIR

FULLER COMPANY
132 Bridge St., Catasauqua, Pa.

GENERAL AMERICAN TRANSPORTATION CORPORATION SUBSIDIARY
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C-272
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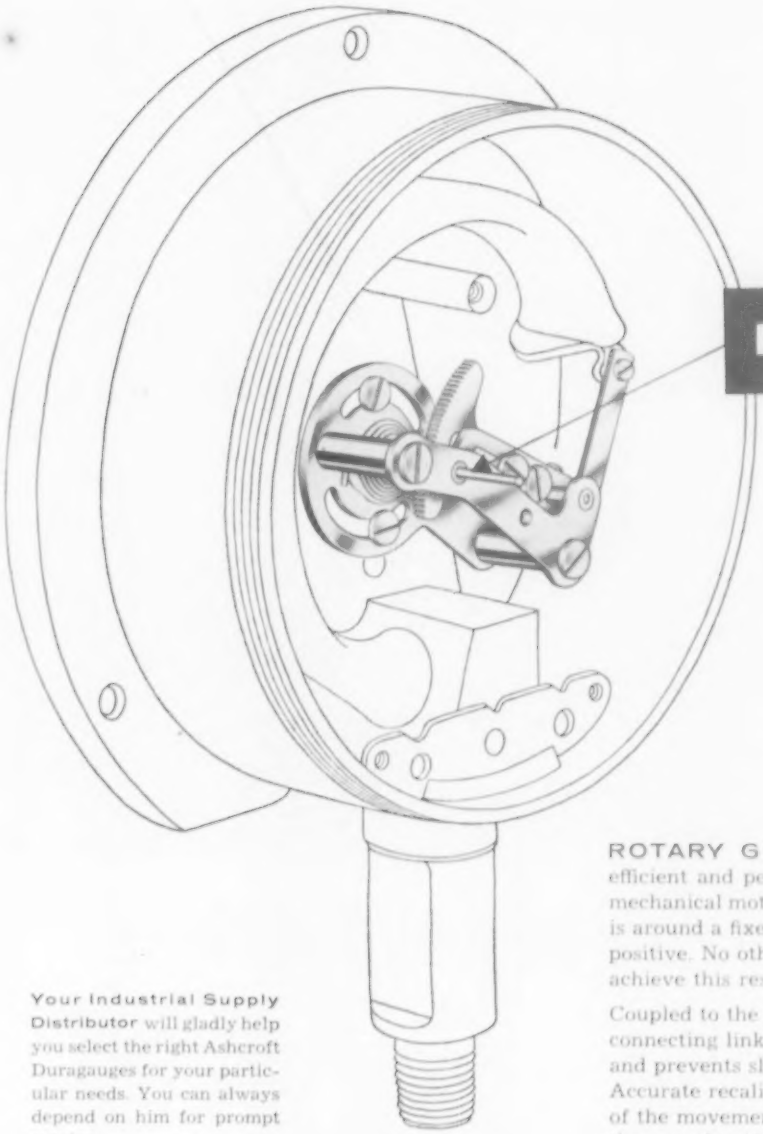


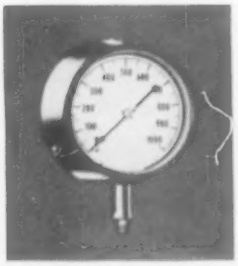
Why does the MOVEMENT in the ASHCROFT DURAGAUGE outperform all other types?

ROTARY GEARED MOTION, the most efficient and perfect method of transmitting mechanical motion ever developed. Because rotation is around a fixed center, pointer position is always positive. No other type of movement can ever achieve this result.

Coupled to the movement is a one-piece connecting link that guarantees correct calibration and prevents slippage or parting under tension. Accurate recalibration is easy from front or rear of the movement. Universal adjustability permits the use of uniformly graduated dials, thereby facilitating maintenance.

The Ashcroft Duragauge is available with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. There are case designs and materials, Bourdon tube materials, pressure ranges and dial sizes to meet your service conditions exactly. Save time, trouble and money. Specify the pressure gauges of highest sustained accuracy and durability — Ashcroft Duragauges.

Your Industrial Supply Distributor will gladly help you select the right Ashcroft Duragauges for your particular needs. You can always depend on him for prompt service.

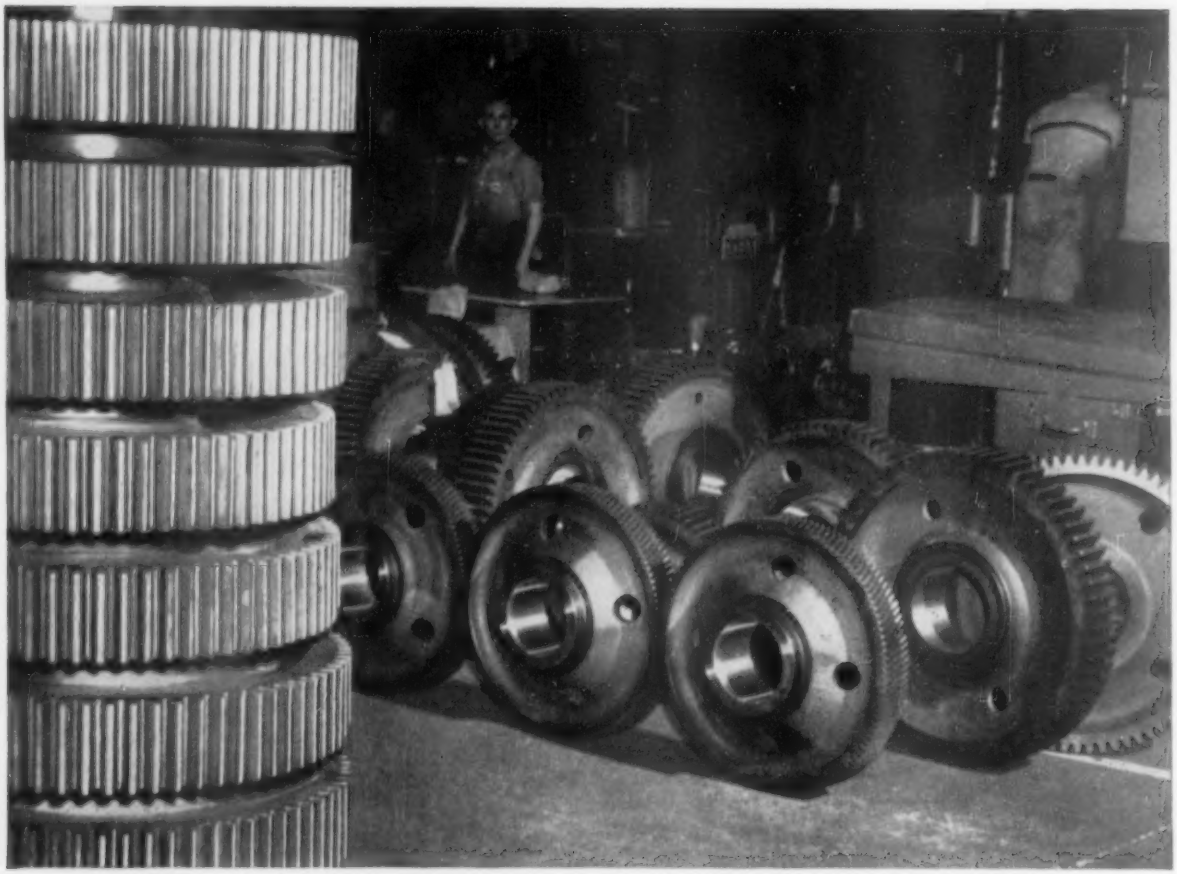


In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*



The gear shop can be proud of these

To the shopman, few things are prettier than a well-machined gear — unless it's a whole inventory of well-machined gears. The stock above is a good example.

Here the beauty is more than skin-deep. The gears are as strong and tough as human skills can make them. All these gears were machined from Bethlehem blanks, which meant that they started with every advantage.

After all, the basis of any good gear is a good, sound blank. And you are certain of top-flight blanks when you get them from Bethlehem. For, at the Bethlehem shops, a special process has been developed for the making of gear blanks; a process that assures high strength, uniform grain flow, and excellent surface texture.

This method of manufacture is unique. It employs the only mill of its kind in the country . . . a mill that upsets, forges, and rolls the steel in a single operation. Let's stress that point. The blank is not just forged, not just rolled, but *both* . . . and both are important to the quality of the finished piece.

You're interested in quality, we know. So specify Bethlehem blanks for your spur, bevel, miter, helical, and other types of gears. You'll find these blanks equally good for crane wheels, industrial wheels, turbine rotors, clutch and brake drums, sheave wheels, flywheels, etc. They are available in sizes from 10 to 42 in. OD.

For additional information, ask us to send you Booklet 216. It is crammed with pictures and interesting data. No charge, of course; just drop us a card.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Recover Valves

FOR RE-USE!

You can recover valves for future use, from all types of temporary or semi-permanent connections, by using Mueller Save-A-Valve Drilling Nipples.

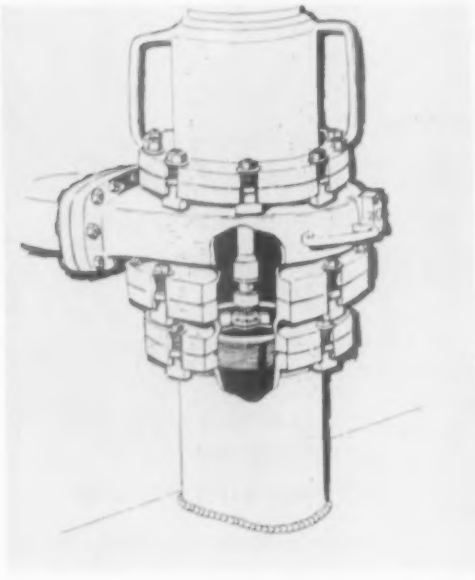
Inner thread in nipple receives threaded completion plug, which is inserted through the valve. Mueller Drilling or Completion machine makes insertion under pressure without loss of fluid. Completion plug seals nipple and permits removal of the valve.

Separate completion cap attaches to nipple and provides a double seal against leakage as well as protecting nipple for re-use at any time. A complete range of sizes from ¾" through 8". Pressures to 1200 p.s.i. Write for complete information.

MUELLER CO.

Dependable Since 1857

MAIN OFFICE & FACTORY DECATUR, ILLINOIS



This is Why the Nash is the Most Simple Compressor

It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods Data on these pumps sent immediately on request

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature automatically maintained.

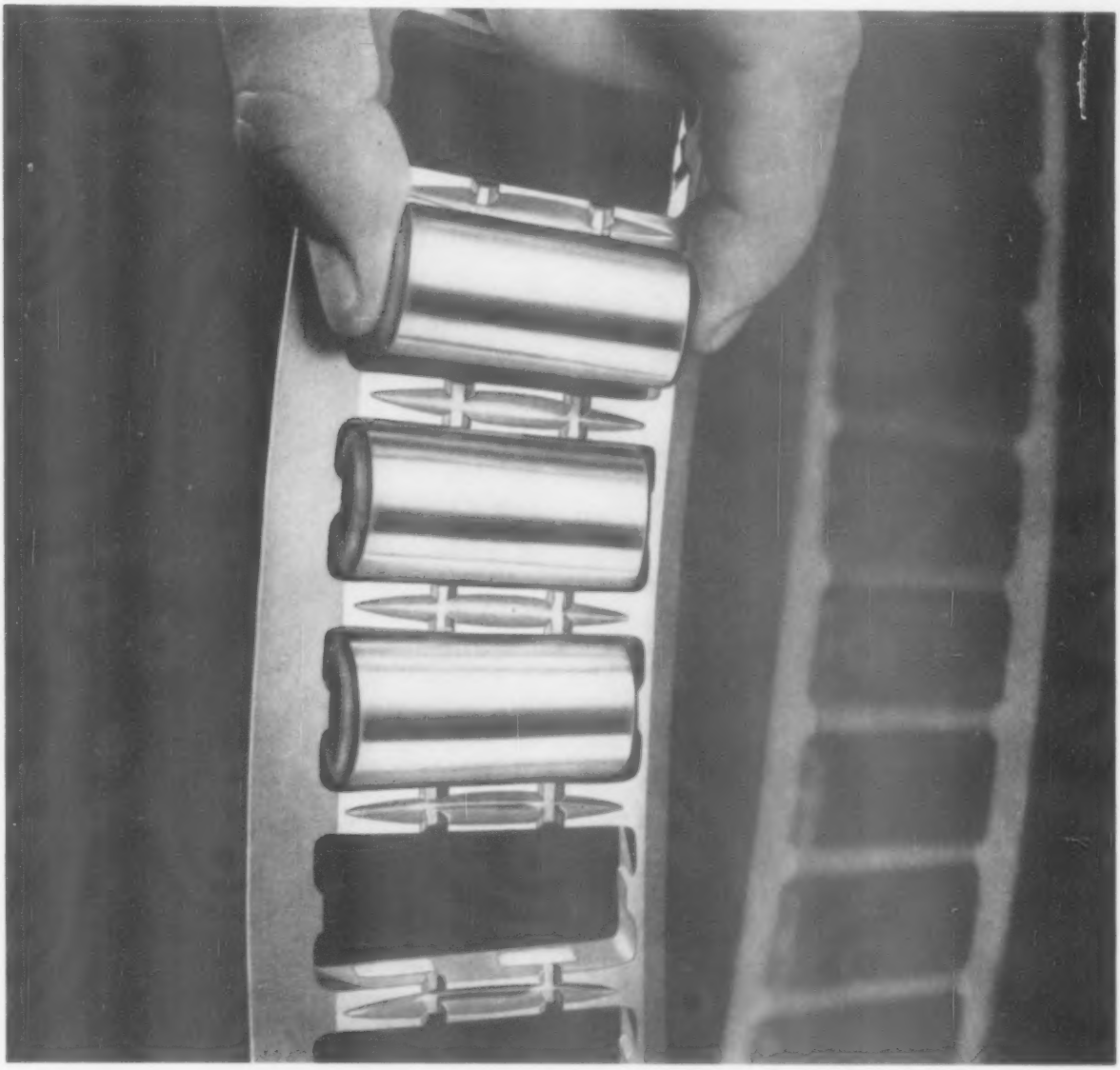
Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

313 WILSON, SO. NORWALK, CONN.

TORRINGTON *TAPERED ROLLER* BEARINGS



Accurately caged . . . to cut your costs!

The one-piece, cast-bronze cage you see above is one of the reasons why TORRINGTON Roller Bearings give long, low-cost service. Note the individual roller retainment, for example. This helps keep the rollers thoroughly lubricated at all times. Race surface inspection is simplified. The machined pads in each roller pocket make sure the rollers are guided accurately at the pitch line. All this to minimize wear . . . lengthen bearing life.

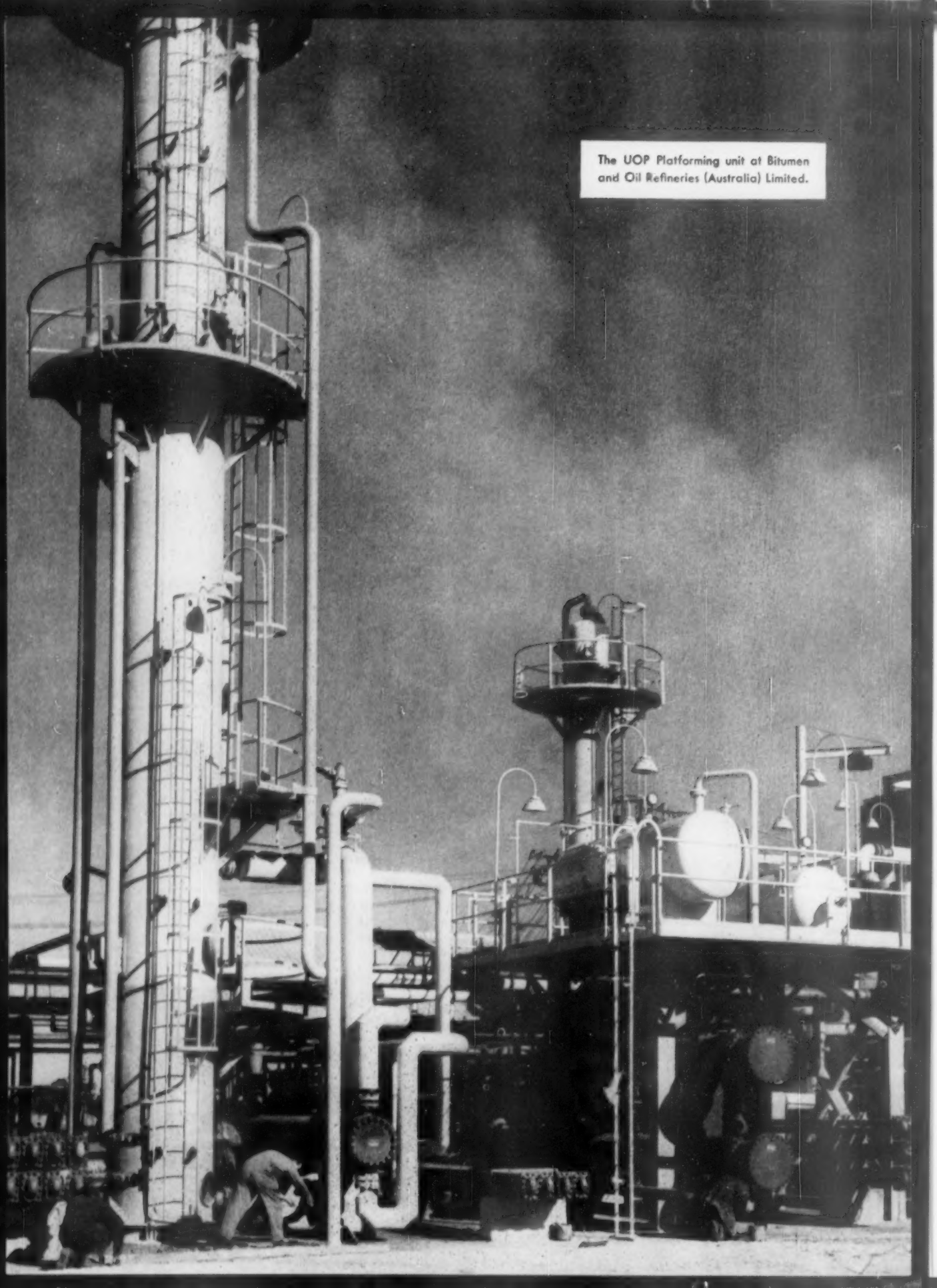
Yes, TORRINGTON Roller Bearings cut your costs. They're made of the finest bearing quality steel available, heat treated by the most modern methods. No wonder they're so rugged . . . so dependable. Specify TORRINGTON *Tapered* or *Cylindrical* Roller Bearings for heavy loads and low maintenance.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District offices and distributors in principal cities of United States and Canada

90th ANNIVERSARY 1866–1956

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller
Needle • Ball • Needle Rollers



The UOP Platforming unit at Bitumen and Oil Refineries (Australia) Limited.

Australian Refiner Reports on 3 Years Operation of UOP Platforming Unit

By E. R. Griffin
General Manager
Bitumen and Oil Refineries (Australia) Limited
Matraville, New South Wales

BORAL has the distinction of being the first refiner outside the American continent to install a UOP Platforming unit, and in more than three years it has operated absolutely trouble-free. Since it went on stream in July, 1952, it has been shut down only for inspections and for cleaning or changing catalyst. In our opinion, this remarkable record was not only achieved because of careful operating control, but reflects, as well, the sound processing techniques of operation provided through the application of UOP fundamental basic research and a well designed and engineered process.

E. R. Griffin

The unit at our refinery set a world record for catalyst life, the first charge having lasted for nearly two years. It was dumped on July 1, 1954, having processed 253 barrels of charge per pound of catalyst. A Platformate yield of 94.1 per cent, based on reactor charge, was realized over the entire run and at the time of dumping, it was still making the 72 octane (motor method) standard grade of motor fuel called for in the local market with the addition of only 1.2 cc. TEL. Making such an octane proved to be an easy job for the Platformer even though Middle East naphthas, processed in the unit, generally are among the least desirable charge stocks for catalytic reforming operations.

Now, the standard grade motor fuel has been increased to 79-81 (research), and a premium grade of 90 research octane has been introduced, both of which are being produced by the Platforming unit without difficulty.

The decision to install the Platforming unit, which had an original design capacity of 1,500 barrels per stream day, came after an exhaustive investigation in which it was determined that this process would give us the flexibility we needed in the selection of a charge stock. Our refinery in Sydney then consisted of a 5,000 B/SD two-stage distillation unit and an asphalt converter unit. A synthetic crude oil, to which was added a small quantity of cracked gasoline, was obtained from the Persian Gulf area for processing into Diesel oil, fuel oil and various grades of asphalt. The gasoline was distilled and sweetened for sale in the local market.

Economics dictated that the processing of whole crude would be more profitable than running synthetic crude because low octane straight run gasoline obtained from whole crude could be upgraded in octane by catalytic reforming with much higher yields than could be obtained by conventional thermal reforming, which was expensive and unsuitable for our requirements.

Having decided to install Platforming, we asked UOP to send an engineer to Australia to assist us in planning for the construction of the unit. Engineering, detailed drafting and purchasing of items not readily obtainable in our country for erection of the Platformer were handled by UOP, which licensed the process. Refinery personnel built the unit.

We decided in 1954 to expand our refining facilities and improve the quality of our other petroleum products. After discussions with UOP on the best course to follow, we concluded that the Unifining process would be most adaptable to our needs. Universal was requested to prepare the engineering and detailed drafting and to purchase hard-to-get items as well as to prepare the design and engineering for revamping the Platformer to increase its capacity to 2,500 B/SD, and to prepare the process designs for a 10,000 B/SD topping plant.

Exhaustive work in Universal's laboratories resulted in the design of a "tailor-made" Unifining unit which processes a combination of Diesel fuel and aromatic light oil produced from an oil gas plant located in Sydney. The Unifining unit has made BORAL one of the first refiners in the world to offer Diesel fuel purified by the use of hydrogen.

In conclusion, we would like to say that our association with UOP not only has enabled us to keep abreast of the most modern refining techniques, but it has made available to us technical "know-how" which has proved invaluable.

DOWN UNDER
BORAL USES UOP
PLATFORMING TO PROVIDE
AUSTRALIAN MOTORISTS
WITH HIGH QUALITY
MOTOR FUEL

designed, engineered and licensed by

UNIVERSAL
OIL PRODUCTS
COMPANY

30 ALGONQUIN ROAD,
DES PLAINES, ILL., U.S.A.

Forty Years Of Leadership
In Petroleum Refining Technology

Dependable

Bucyrus-Erie cranes hold down plant maintenance costs

Thoroughly reliable, easy-to-service Bucyrus-Erie lifting cranes give you the high degree of availability you need for efficient handling of plant maintenance problems. Simplicity of design is one big reason.

The entire machinery layout is specially designed to provide free accessibility for servicing. To work on one part you don't have to remove two or three others first. Main shafts are placed side by side, not stacked up vertically, so that it's easy to get at the brakes and clutches.

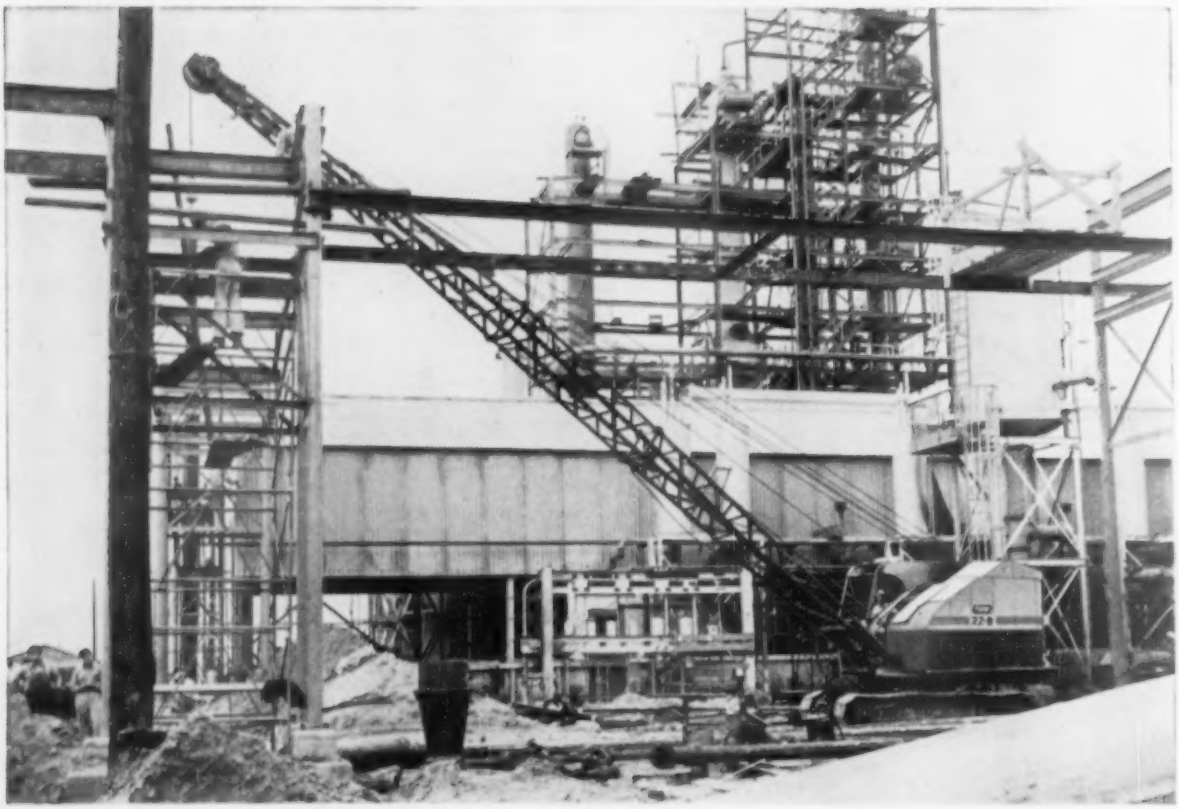
There are many other Bucyrus-Erie headline features that add up to a higher percentage of actual working time each day — that help you hold down plant maintenance costs. Get in touch with your Bucyrus-Erie distributor now for the full story. There are eight crawler-mounted cranes in the Bucyrus-Erie line — lifting capacities depend on length of boom, size of crawlers, and counterweight. Also investigate the 15-ton Model 15-B and 25-ton Model 22-B Transit Cranes — carrier-mounted to provide rubber-tired mobility. All cranes are fully convertible to excavator operation.

161E55

BUCYRUS ERIE

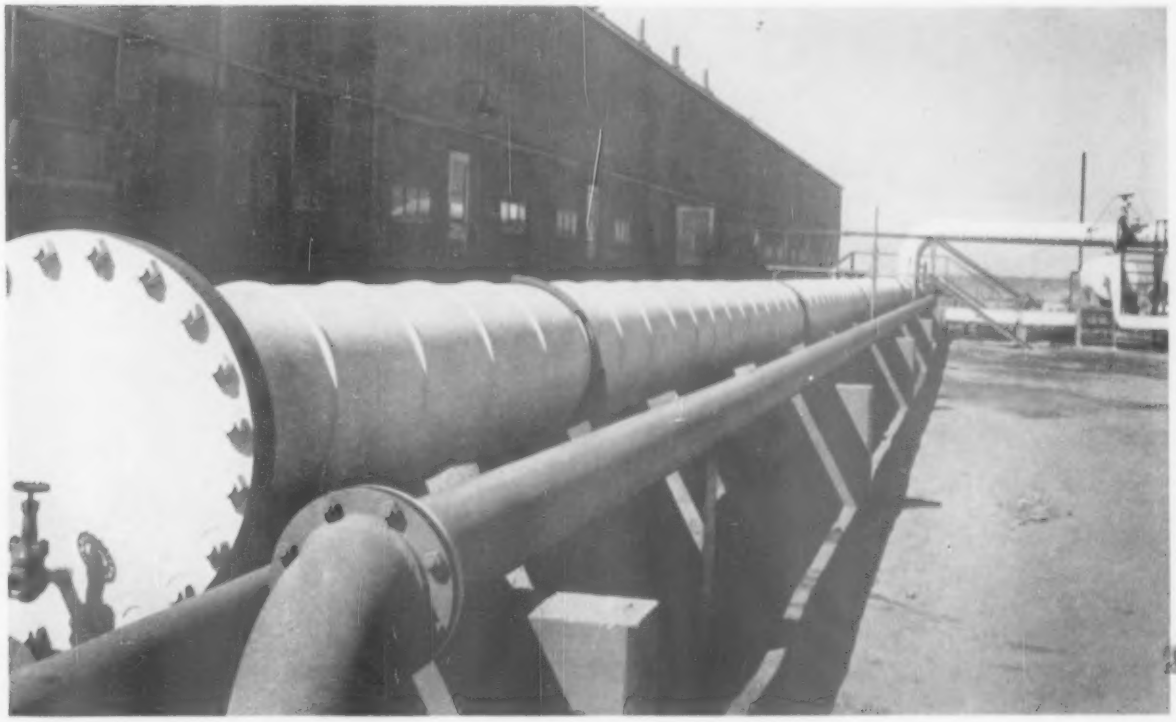
South Milwaukee
Wisconsin

75 YEARS OF SERVICE to Men Who Shape the Earth



It's the DIFFERENCE

You *Can't* See that Counts!



It's easy to distinguish Naylor pipe from other light weight pipe by its familiar spiral. But what you can't see from the outside is the extra performance built into this lockseamed, spiralwelded pipe.

Once you use Naylor for gas gathering and field processing piping, the difference in service becomes apparent. First, the extra strength and safety you get . . . because of the spiral truss which acts as a continuous expansion joint to absorb shock loads, stresses, and strains. Second, the greater collapse strength . . . which permits operation under either vacuum or pressure.

Remember, too, that this Naylor structure maintains its true cylindrical form and holds its diameter accurately. Naylor Spiralweld comes in diameters from 4" to 30" and is available with standard weight pipe ends for faster, stronger field welds.

Write for Bulletin No. 507 or call our distributors.

NAYLOR PIPE

NAYLOR PIPE COMPANY
1232 East 92nd Street
Chicago 19, Illinois

Exclusive Distributors in
Mid-Continent and Gulf Coast Areas
MID-CONTINENT SUPPLY CO.
Ft. Worth, Texas and Branches

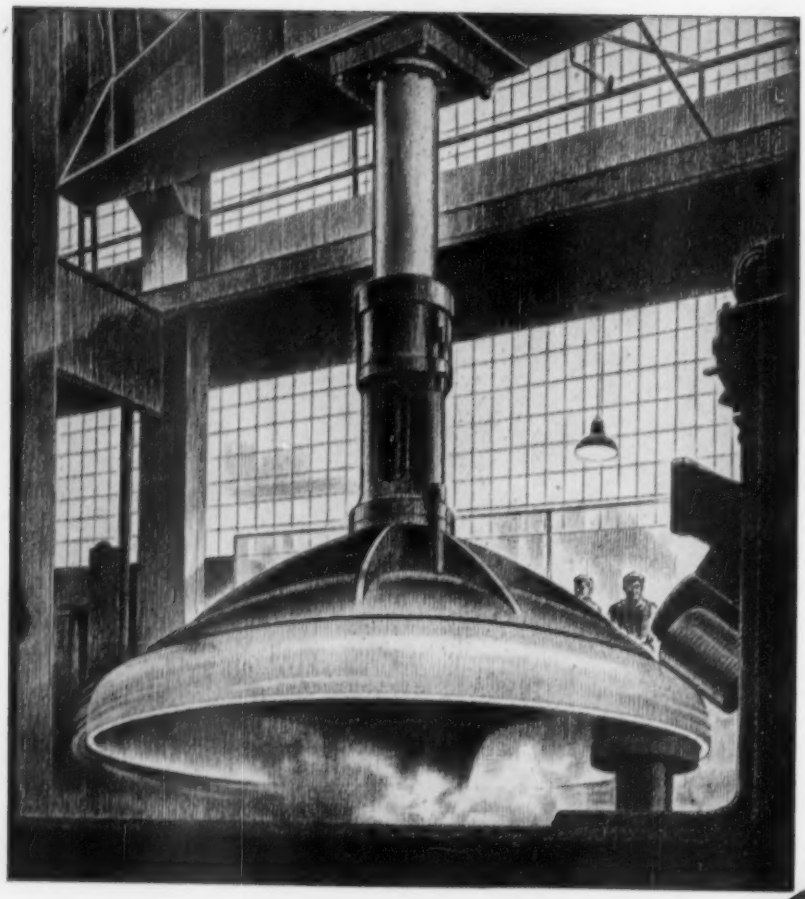
Eastern U. S. and Foreign Sales Office: 350 Madison Avenue, New York 17, New York

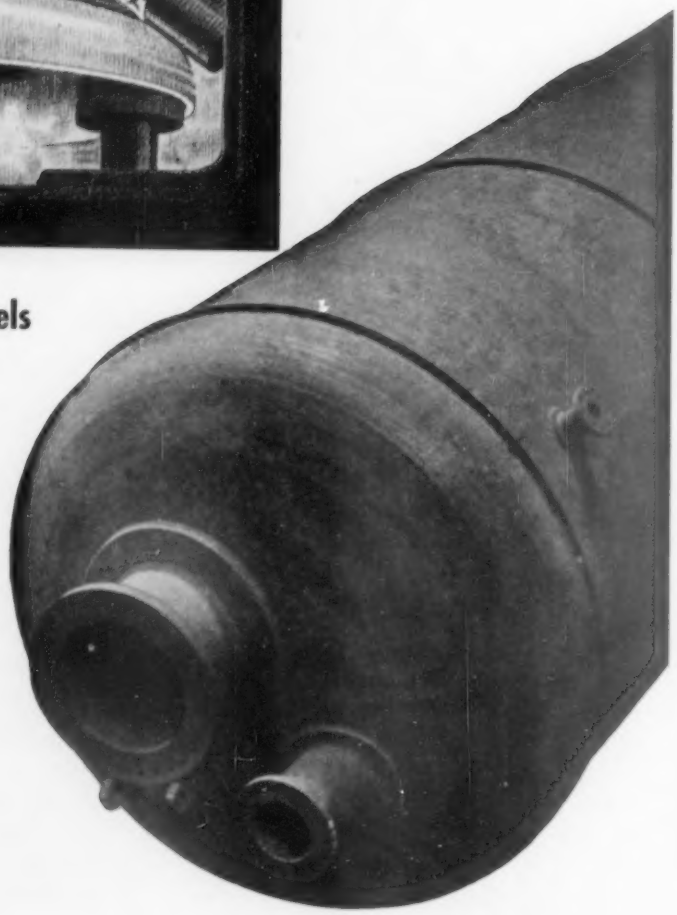
Spinning

SAVES METAL

—CUTS TOOL COSTS

The design and production of Pressure Vessels may be greatly facilitated by using dished and flanged ends spun by Harveys on the Rotarpress. They combine semi-ellipsoidal form with large knuckle radius. A substantial reduction in plate thickness can be effected, and in most cases tool costs are eliminated.





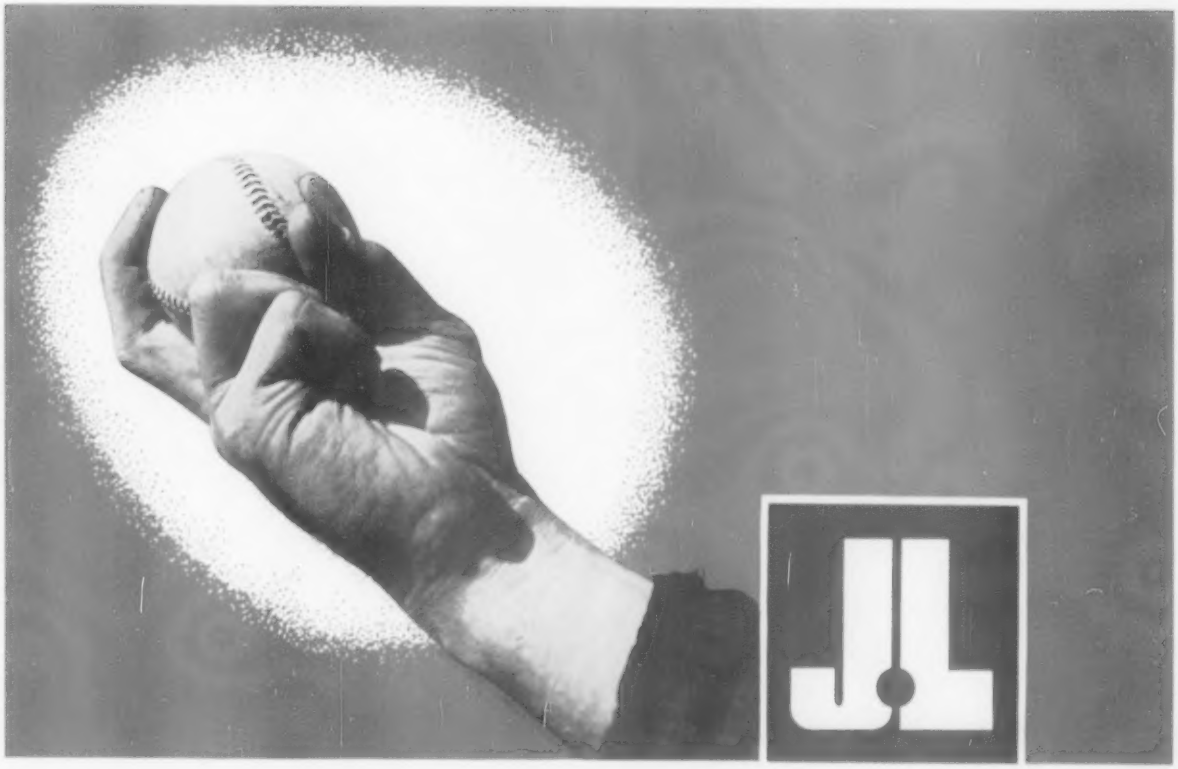
'Rotarprest' Ends for Pressure Vessels

can be supplied in Mild, Alloy and Clad Steels and Non-Ferrous Metals. The capacity of the Rotarpress ranges from 5 to 15 feet diameter, and $\frac{3}{8}$" to 4" thickness. Knuckle radii and depth may be varied to meet individual requirements.

Please ask for List No. OG-881 giving full range of sizes.

Harvey

G. A. HARVEY & CO. (LONDON) LTD.
WOOLWICH ROAD, LONDON, S.E.7
ENGLAND
Cables: "Cheaper, London"



Here's the pitch on dependable WELDING FITTINGS

Welding fittings from J&L Supply are guaranteed accurate within ASA tolerances. Cut your pipe with confidence!

- Store stocks for your pick-up requirements.
- More comprehensive stocks centrally located and promptly available.
- On special specifications, direct factory shipment from the most versatile plants in America — welding fittings engineered to enable you to improve piping designs and reduce costs.

The line includes fittings of easy-to-weld JALTEN, made by J&L. Ideal for use with high-tensile, high-yield pipe.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

SERVING THE UNITED STATES AND CANADA

7-G

OIL FIRE!

SNUFF IT FAST WITH POWER PLUS!

AIM THE HORN, pull the trigger, and wham! Another stubborn oil blaze dies . . . thanks to the extra fire-killing power of Kidde Dry Chemical Extinguishers!

Examine a Kidde Dry Chemical Extinguisher closely, and you'll see why Kidde is first choice with firefighting experts the nation over. These lightweight extinguishers (for fast, easy aiming) have Kidde's patented diffuser horns which give you up to 44% *more* coverage than you get with conventional dry chemical extinguishers. Dependable and easy to operate, Kidde's special trigger-finger grip permits even a novice fire fighter to tackle a blaze immediately . . . with confidence.

Especially effective in fighting fires in L-P gas, oil, gasoline and other flammable liquids, Kidde Dry Chemical Extinguishers will not pack. Cartridge-operated Kidde extinguishers are available in 20 and 30-pound capacities, while Kidde pressure-operated models come in capacities of 5 and 10 pounds. All Kidde pressurized extinguishers have easy-to-read, dustproof pressure gauges, can be charged to U.L.-approved working pressures (150 pounds) at any commercial air pump. In addition, the 10-pound model can be charged to 250 pounds for extra fire-fighting punch! It is U.L.-approved at either pressure.

For more information on the complete Kidde Dry Chemical line, write today for Kidde's Catalog P-8.

Kidde 20-pound dry chemical portable

Kidde

The words "Kidde", "Lux", "Lux-O-Matic", "Fyre Freez" and the Kidde seal are trademarks of Walter Kidde & Company, Inc.

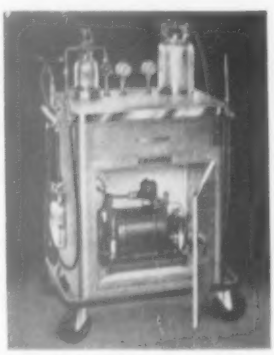
Walter Kidde & Company, Inc.
454 Main Street, Belleville 9, N. J.
Walter Kidde & Company of Canada, Ltd.
Montreal—Toronto

Leland motors here can't fail

The explosion-proof, motor-driven suction and ether unit in a modern operating room *can't fail*. It must pump highly volatile ether to maintain anesthesia, and drain excess body fluids literally to prevent drowning!

Leland engineers—working closely with the J. Sklar Manufacturing Company ...helped obtain the *first and only U.L. Approval ever given an electrically driven apparatus of this type!*

Electric motors? *Leland* knows how to make them. And to tailor them to your specific needs. For the answer to an unusual problem, or information on the complete line of quality motors from ½ to 5 hp—soon to 20 hp—in all standard types and enclosures, contact us today.



Class I, Group C Underwriters' Approved explosion-proof Leland Motor dependably powers this dual-purpose Sklar hospital unit.

Another AMF Product

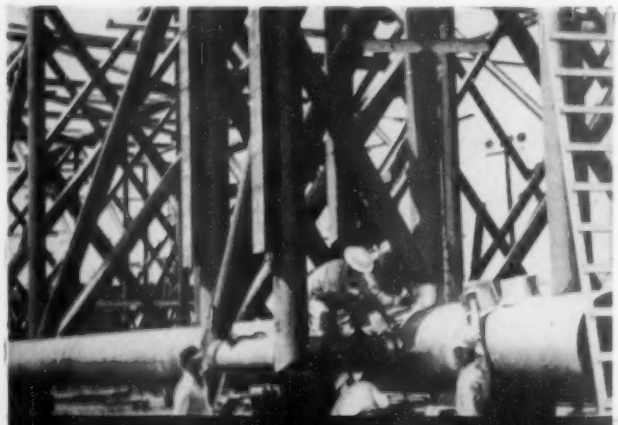
LELAND MOTORS

THE LELAND ELECTRIC COMPANY

Dayton 1, Ohio

Division of AMERICAN MACHINE & FOUNDRY COMPANY

products for the Oil Industry by Avondale



products by AVONDALE . . . offshore drilling platforms, drilling barges, towboats, tugboats, barges—any and all kinds of marine equipment for the Oil Industry! AVONDALE products are in step with the fast-moving Oil Industry. AVONDALE products are known and famous in the Oil Industry. If you are considering construction or repairs—call on AVONDALE!

OIL TOOL SERVICE • HARVEY, LA. • FI 1-1211

SHIP BUILDING • SHIP REPAIRING • FOUNDERS • PROPELLERS • STRUCTURAL STEEL

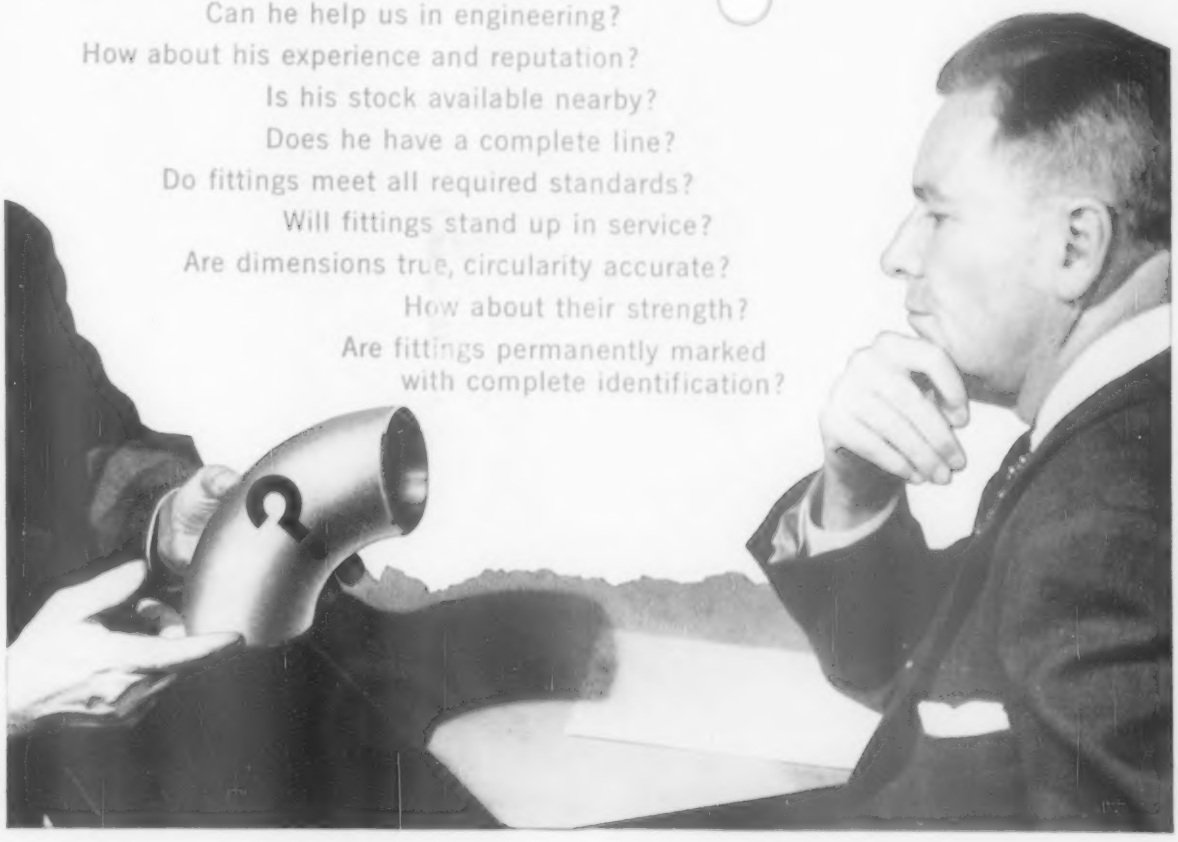
AVONDALE MARINE WAYS, INC.

CABLE ADDRESS "AVONWAYS"

P.O. BOX 1030 • PHONE UNiversity 6-4561 • NEW ORLEANS 8, U.S.A.

why run a risk with Question-Mark fittings

Is the manufacturer a piping specialist?
Can he help us in engineering?
How about his experience and reputation?
Is his stock available nearby?
Does he have a complete line?
Do fittings meet all required standards?
Will fittings stand up in service?
Are dimensions true, circularity accurate?
How about their strength?
Are fittings permanently marked with complete identification?



No unanswered question...no risk

when you buy known fittings

YOU SAVE purchasing time and avoid trouble later on when you buy TUBE-TURN* Welding Fittings and Flanges. Made in U.S.A. by the leader in the field, these products give you top quality and uniformity, backed by unmatched engineering service and nearby complete-line distributor facilities. They meet *all* American Standard and Safety Code requirements. Each product is permanently identified by the "TUBE-TURN" trademark with complete size and material designation. You can't get a better bargain in welding fittings and flanges than from your trusted Tube Turns' Distributor!

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Cleveland • Detroit • Chicago • Kansas City • Denver
Los Angeles • San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

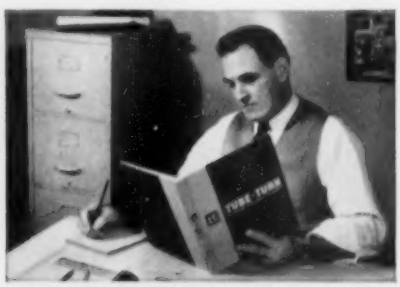
*"TUBE-TURN" and "TT" Reg. U.S. Pat. Off.

POSITIVE IDENTIFICATION

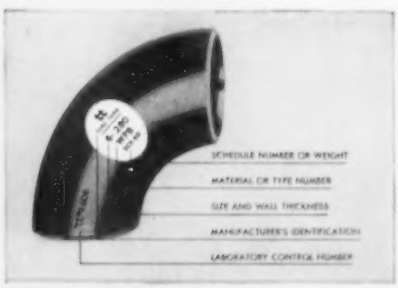
THE WELDER KNOWS he's getting the exact fitting specified on the blueprint because the fitting is clearly marked with all designations.

Complete...Permanent Identification!

THE STOREROOM WORKER KNOWS he is selecting the right fitting when it's marked "TUBE-TURN". The fitting bears complete information called for on the requisition.



THE DESIGNER KNOWS that his specifications will be carried out precisely where his drawings call for "TUBE-TURN products". At every stage . . . from purchasing to pipe installation, people KNOW what they're getting and using.



CLEARLY MARKED. TUBE-TURN* Welding Fittings are completely identified as to dimensional and metallurgical facts. Here is your assurance that you have the RIGHT fitting, and that it has passed Tube Turns' rigid inspection and quality control.

This is just *one* reason why you should specify the leading brand of fittings and buy from your trusted Tube Turns' Distributor.

TUBE-TURN Welding Fittings and Flanges are made in U. S. A.
They meet *all* U. S. piping code specifications.

TUBE TURNS

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tt TUBE-TURN

*"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

The ocean-going platform, shown here testing its 140-ft sea legs on the Mississippi River near Vicksburg, provides over a half acre of area for drilling operations storage of pipe and tools, offices, and air-conditioned living quarters for 42 men.

GOING UP!

. . . Portable Offshore Drilling "Island" is Raised, Lowered by Allis-Chalmers Diesel Power

Perched nine stories above the water is the $2 million offshore portable island built by R. G. LeTourneau, Inc. of Longview, Texas, for tidelands oil exploration and drilling.

This revolutionary giant eliminates the time and cost of building or rebuilding a structure at each new drilling site. Instead it is towed to the location, plants its feet firmly on the bottom of the Gulf, and hoists itself high above the waves to serve as a platform for drilling. When operations are finished, it simply pulls up its feet and is floated away.

As soon as drilling is completed at one location, the legs are raised and the structure towed to a new drilling site.

Dependability and over-all economy were prime considerations in choosing power for the critical task of lifting and lowering this tremendous 8,000,000-lb structure. Four Allis-Chalmers 8DAS-1125 supercharged diesels selected for the job (each producing 300-plus hp) drive generators to furnish electricity for the 63 motors on the three stilts.

The same qualities that fit Allis-Chalmers diesels for this application make them standouts in drilling work everywhere. Let your Buda Division dealer give you complete information.

ALLIS-CHALMERS, BUDA DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS A-C

BE-1

Delta's Scene
IS ALWAYS CHANGING

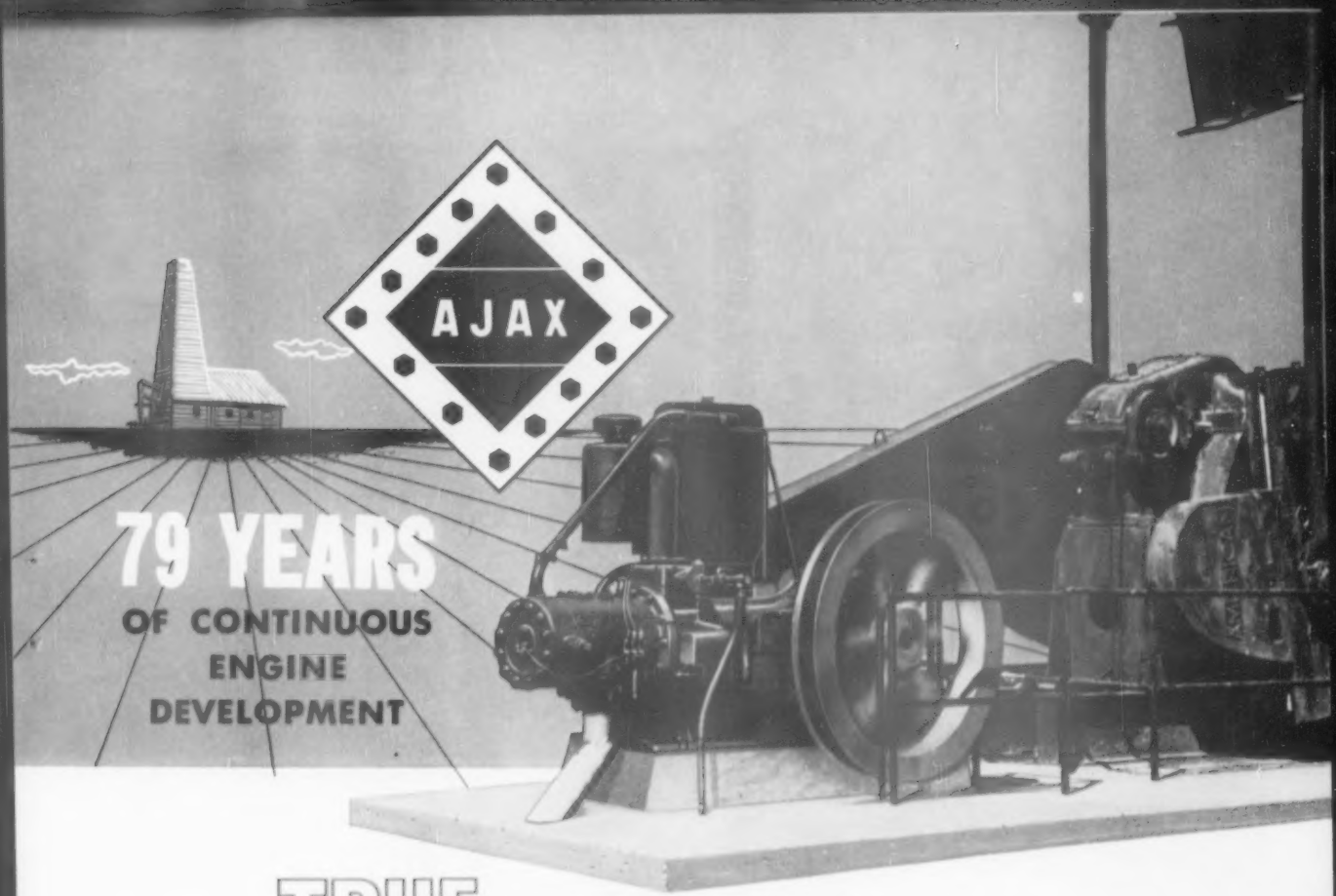
Through the window of the Delta field engineer's office, the scene is always changing. Delta has built gasoline plants, recycling plants, and other types of processing plants in remote and comparatively inaccessible locations. We are equipped to design and to construct your plant where you need it and within its assigned budget. From special design to a turnkey operation, let Delta engineer your project.

DESIGNING ENGINEERING DELTA CONSTRUCTION

DELTA ENGINEERING CORPORATION

Engineering Contractors

2121 San Felipe Rd. • P. O. Box 13027 • Houston, Texas



TRUE *since the beginning of OIL . . .*

A SINGLE CYLINDER DOES IT BEST

The cheapest and most dependable power in the oil producing business has always been provided by the horizontal, two cycle, crosshead type gas engine. This was true for the old-timers and it's true today. The only difference is in the engines!

Today's Ajax Gas Engine is a highly-engineered, precision product. Retaining all the essential simplicity of its great prototype, the Ajax you buy today is a product of the best design, the finest craftsmanship and the most suitable materials it is possible to obtain.

And Mr. Producer, if gas is obtainable, Ajax will deliver cheap power! *Ask your Supply Man for the particulars.*

Ajax MODERN GAS ENGINES

- SINGLE CYLINDER
- HORIZONTAL
- TWO CYCLE
- LOOP-SCAVENGED
- CROSSHEAD TYPE
- THERMO-SYPHON COOLING

for

ECONOMY
SIMPLICITY
LOW MAINTENANCE
CONTINUOUS DEPENDABILITY
LONG USEFUL LIFE

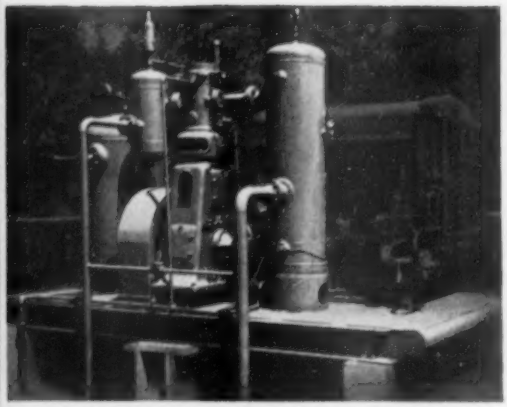
AJAX IRON WORKS

Builders of GAS AND OIL ENGINES, PRESSURE PUMPS, STEAM DRILLING ENGINES, INDUSTRIAL STEAM ENGINES

CORRY, PENNSYLVANIA

Oil Field Distributors: THE NATIONAL SUPPLY CO., PITTSBURGH, PA.
R. B. MOORE SUPPLY CO., BOLIVAR, N.Y. • BETHLEHEM SUPPLY CO., TULSA, OKLAHOMA

THE ONLY MODERN-DESIGN COMPRESSORS FOR GAS BOOSTER OPERATION



Joy WGB-110 Gas Compressor. Inlet pressure 150 psig; Discharge pressure 500 psig. Capacity 1.028 MMCFD. "Packaged" by McNamar Boiler & Tank Co., Tulsa.

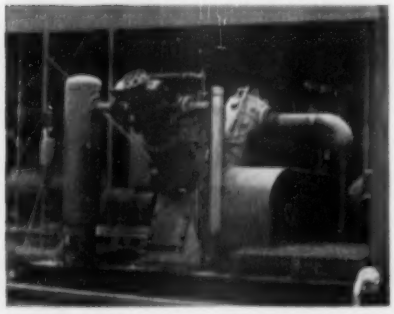
JOY *Packaged* GAS COMPRESSORS

Modern Joy Packaged Gas Compressors are backed by a century-old reputation for low maintenance and long service. These *time-proved* features make Joy Compressors the most reliable for gas gathering, repressuring, or gas lifting:

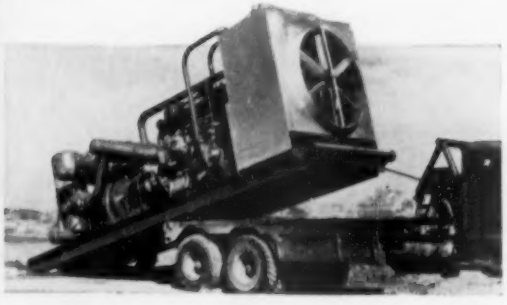
- **Field-replaceable cylinder liners.**
- **Field-replaceable crosshead guides.**
- **Patented Joy "Dual-Cushion" valves.**
- **Full force-feed lubrication.**
- **Anti-friction main bearings.**

Joy Gas Compressors are available in space-saving vertical, V-type, and semi-radial designs . . . single or two-stage units with cylinder sizes from 3" to 13½". Four different frame types accommodate a power range of 50 to 400 HP.

For the most efficient compressor for your needs, consult a Joy Engineer or write to ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*



Joy WNB-112 Gas Compressor. Inlet pressure 35 psia; Discharge pressure 665 psia. Capacity .85 MMCFD. "Packaged" by Oil & Gas Supply Company, Houston.



This photo of a Joy WNB-114 Gas Compressor Package being unloaded onto concrete pad clearly illustrates portability of unit. Inlet pressure is 5 psig; Discharge pressure is 150 psig. Capacity 2 MMCFD. "Packaged" by McNamar Boiler & Tank Co., Tulsa.

Write for FREE Bulletin 84-31

Consult a Joy Engineer

FOR PORTABLE ROTARY DRILLS, AIR COMPRESSORS, GAS GATHERING COMPRESSORS, PORTABLE LIGHTING LINES

WSW 06054-84

JOY

SPECIALISTS IN THE COMPRESSION AND MOVEMENT OF AIR AND GASES SINCE 1885

HOW WE CHEMICALLY CLEAN PIPE TROUBLES AWAY!

Here you see pipe about to take a bath. A boiling, bubbling caustic bath followed by a rinse that instantly removes grease, cutting oils and other surface coatings or impurities. HILL, HUBBELL *originated* the hot caustic bath and rinse as an essential first step in pipe protection, that helps assure maximum trouble-free life of coated pipe. One of many such developments born of HILL, HUBBELL know-how, the hot caustic bath is—

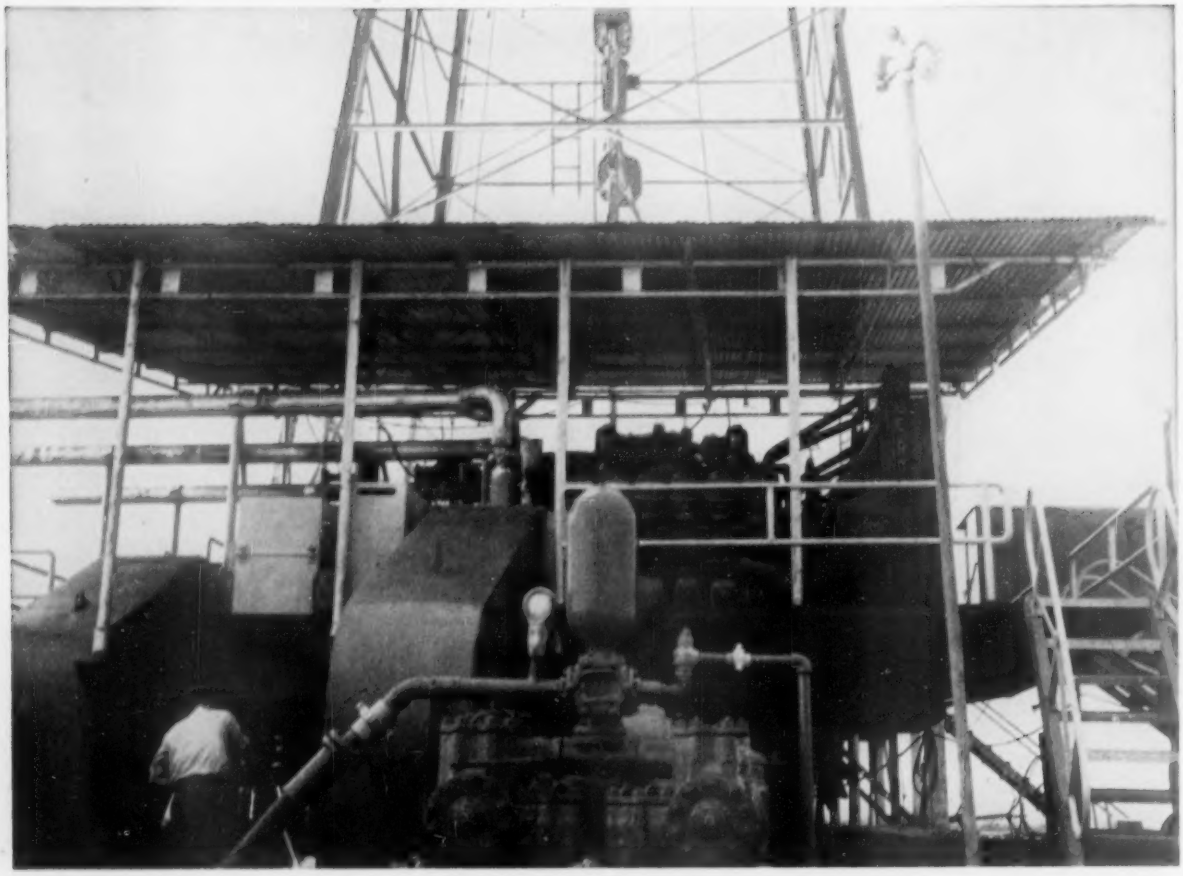
Another "first" by the first name in pipe protection . . .

HILL, HUBBELL & COMPANY

FACTORY APPLICATORS OF COATINGS & WRAPPINGS

DIVISION OF GENERAL PAINT CORP.

3091 MAYFIELD ROAD, CLEVELAND 18, OHIO



Deephole Drilling . . . In a Hurry !

. . . the acceleration, lugging power, and dependability you get from Le Roi L3460 and L4000 engines mean faster round trips and lower drilling costs.

WHEN you have to go deep you need plenty of horsepower. And the place to get it is from Le Roi's L3460 with 600 max. hp. or its big brother, the L4000 with 655 max. hp.

You get much more, too. You get compactness. These V-12 overhead-valve engines are only 164 in. long. That makes them ideal for drill-rig installation, because they pack a lot of power in a small space — give you more horsepower per dollar.

But that's not all you get from these high-output engines. They represent the first, truly new design concept in 15 years. They have improved fuel economy; integral crankcase and cylinder construction for greater rigidity; longer bearing life; hydraulic valve lifters; better manifolding; husky crankshaft with integrally forged counterweights for unbelievably smooth operation — modern features that mean lightning response to load demands, outstanding performance and dependability.

Like all Le Roi engines, they're built to stand oilfield handling; they're easy to service; they have a wide speed range up to 1350 rpm; and they operate on natural gas, butane, or gasoline.

Ask your supply house or Le Roi distributor to show you an L3460 or L4000 at work. See for yourself why they can help you make hole faster. Literature is also available — just write us for it.

P-179

LE ROI *Division of Westinghouse Air Brake Co.*

Milwaukee 1, Wisconsin

PORTABLE AIR COMPRESSORS

TRACTAIR

STATIONARY AIR COMPRESSORS

AIR TOOLS

ENGINES

Beacon • • • and Your Refinery

The marketing of petroleum products is complex. It requires a well coordinated team experienced in both domestic and industrial markets. At Beacon Petroleum Company you will find such a team. Specialists in every phase of petroleum marketing and transportation devoted to one thing . . . moving *your* products successfully to their proper markets.

If you want to successfully market *any* type of petroleum product — contact Beacon . . . or if you want to *buy* any petroleum products . . . contact Beacon.

BEACONGAS

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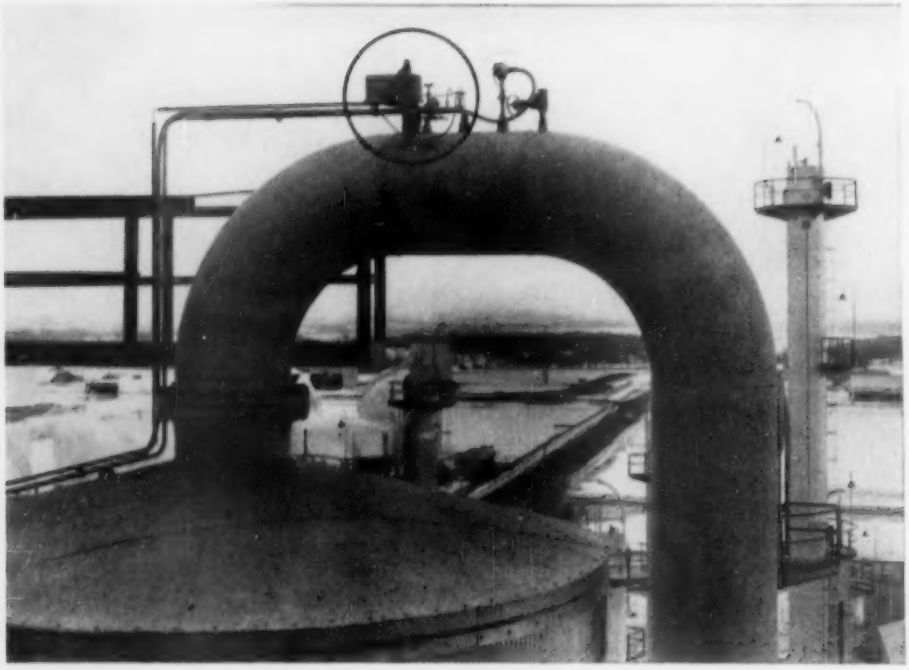
TULSA • HOUSTON

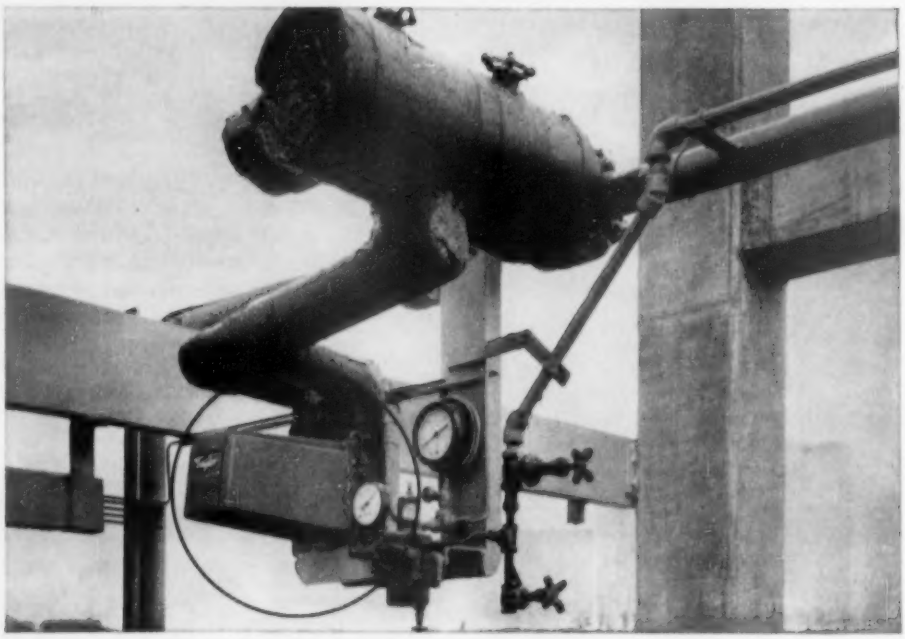
MARKETERS OF NATURAL GASOLINE, BUTANE-PROPANE, MOTOR FUEL, FUEL OILS

For dependable Accuracy in

GREAT NORTHERN AND FLUOR



Br-r-r! It's cold up here! Taylor TRANSAIRE* Temperature Transmitter, with derivative (SPEED-ACT*) response in the measuring circuit, measures the temperature of overhead vapors from the Syn Tower. Based on this measurement, the reflux flow to the tower is regulated by a TRI-ACT* Controller.



Taylor TRANSAIRE 333RD Differential Pressure Transmitter measuring flow of propane, at over 600 psig., used as a purge flow to the reactor. Note that the transmitter has no protective insulation . . . yet it maintains acceptable accuracy limits over the wide range of temperatures in such exposure.

*Trade Mark

Minnesota's -40° to +100°F. Climate

CHOSE TAYLOR TRANSET* SYSTEM

HIGH ACCURACY and dependability are vital requirements for instrumentation installed outdoors in Minnesota's extremes of climate. Both The Fluor Corporation, Ltd. and Great Northern Oil Company have been impressed with the performance of the Taylor instruments at the latter's new refinery at Pine Bend, Minn.

The instruments arrived on the scheduled delivery date—and in good calibration. There were a minimum of instrument problems in start-up and they were "on stream" unusually quickly. In addition to its reliability, the TRANSET system has demonstrated several important benefits to Great Northern.

1. Installation was simplified because there is only one mounting per control station—controllers plug into back of receivers; only three piping connections per station.

2. Training of new operators was simplified, because the 167-ft. graphic panel made it easy for them to visualize quickly the entire process by revealing the complete flow diagram.

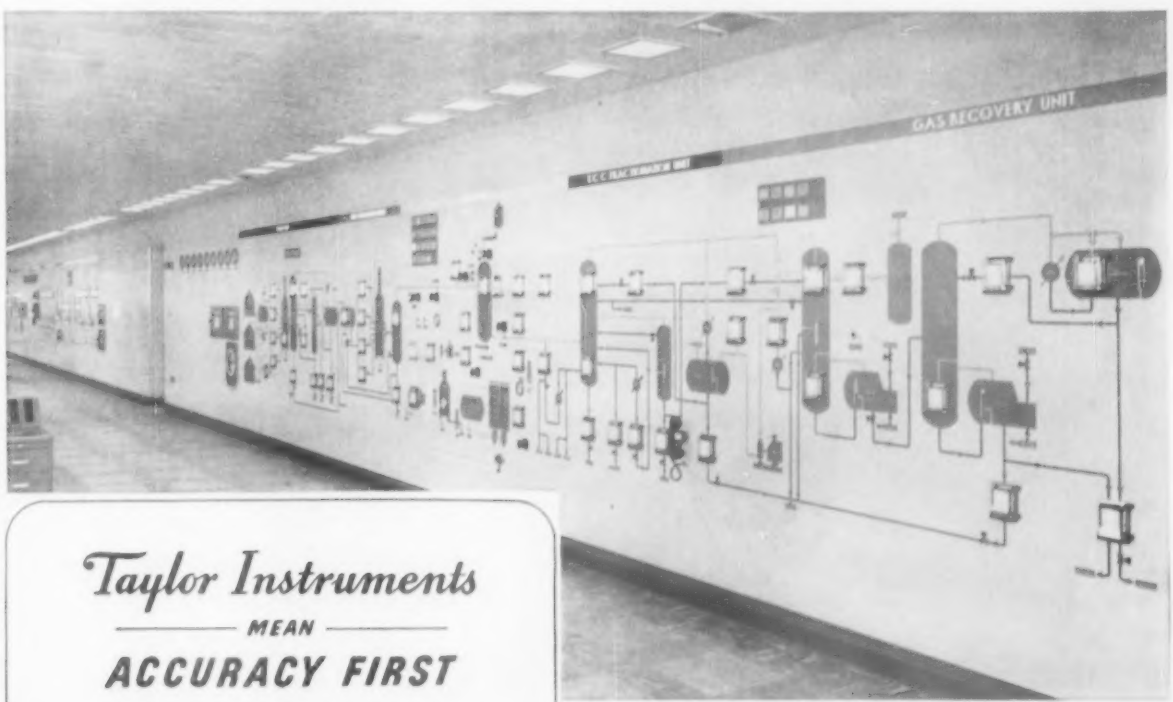
3. Training of Maintenance Personnel was facilitated by means of the plug-in feature which permitted the TRANSET Receivers and Controller to be removed to shop for training purposes—without interfering with piping of panel.

4. Routine maintenance is simplified by same plug-in feature. Checking of questionable controllers or receivers can be done in the shop. Instrument down time is kept to a negligible minimum.

5. Quick analysis of process difficulties is possible because the trend can be plotted by plugging in a recorder in place of an indicator in a matter of seconds.

• • •

We are proud of the part Taylor experience and engineering skill have played in helping Great Northern to maintain their quality standards in their marketing area. If you're not familiar with the scope of Taylor's services, call your Taylor Field Engineer or write Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.



Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

167-Foot Graphic Panel—one of the largest in the industry—not only shows a complete flow diagram and tells what is happening at every critical point in the refining process, but also provides every facility for efficient process control.

PERFORMANCE of
GLOBE 2-CUTTER ROCK BITS

...is in a class by itself!

Wherever Globe 2-Cutter Rock Bits are used, the men in the rig will tell you —

1. The Globe "2-Cutter" drills straighter, in less time . . . because their advanced design has greatest cutting power.
2. The Globe "2-Cutter" stays down longer . . . because they're tougher, stronger.
3. The Globe "2-Cutter" is more versatile . . . used effectively in all type formations . . . often for straightening crooked hole.

Yes, Performance is important, and Globe's superior performance means unmatched value for every rock bit dollar invested.

GLOBE 2-CUTTER ROCK BITS

available in regular and integral jet types

GLOBE
OIL TOOLS COMPANY
GLOBE OIL TOOLS
Serving the Petroleum Industry with the Best in Drilling Equipment

Main Offices and Plant: Los Nietos, California
Prompt Service in All Principal Drilling Areas

They Say—

Computers Guide Decisions

"Computing and data handling machines are freeing the mind of man from many burdensome tasks. However, their value extends much further. Because of the high rate of calculation, it becomes possible in a production or manufacturing operation to compete with real time. Measurements made during the operation often can be processed quickly enough to provide information for controlling the process.

"This control is necessary in the efficient production of oil from underground reservoirs and is the basis of reservoir engineering. The value of the control depends on the assumption that during production the reservoir produces not only oil but also information which, when interpreted in conjunction with laboratory data, serves to permit prediction of future behavior. The adequacy of prediction determines the precision with which optimum control may be chosen."

Henry H. Rachford, Jr., Houston, chemical engineer in production research division, Humble Oil & Refining Co., in address before A.I.M.E.

It Seems Unlikely

Dear Sir:

In looking over my article on "Today's Casing Safety Factors" in the March 12 issue, I noticed a minor misprint in the last sentence of the second paragraph on page 133. As the sentence appears, it reads: "It seems very likely . . . " and should have read: "It seems very unlikely . . ."

Although the change appears to be of minor consequence, it would tend to nullify the point that has been the subject of considerable discussion in the investigation that lead to the preparation of the paper.

Jack R. Hamilton
Gulf Oil Corp.
Houston, Tex.

Who Pays for Trans-Canada?

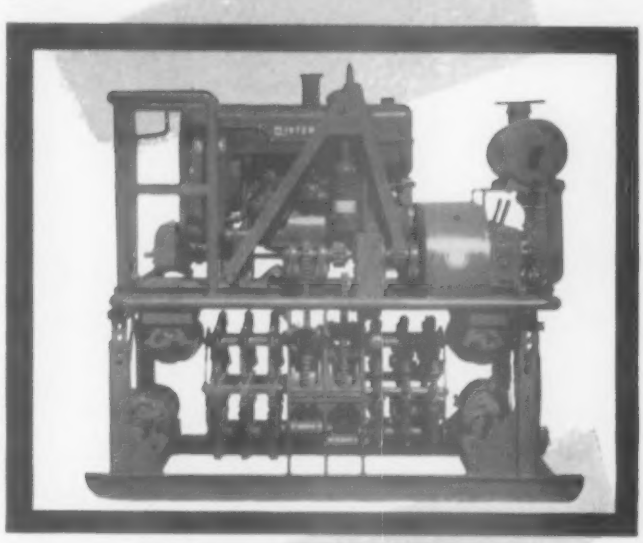
"American leadership in the Trans-Canada project is creating opposition to it.

"The Trans-Canada project is now run chiefly by Americans representing American companies and mainly American capital solely because these are the only men who seem able to line up the large amounts of capital required.

"Canadians want a pipeline but so far it seems we can't find Canadians

cleans pipe more efficiently . . . FASTER!

CROSE LINE TRAVELING PIPE CLEANING AND PRIMING MACHINE



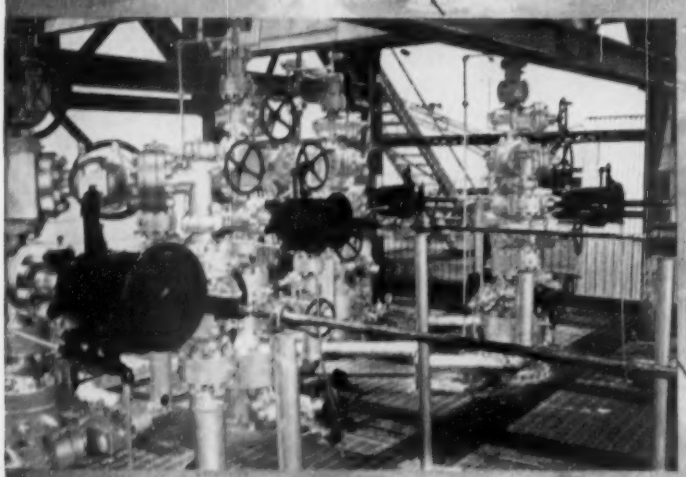
This versatile pipe cleaning and priming machine can be used for line traveling operation or with stationary base (shown above) for yard cleaning and priming—either way it is better built and more efficient to give you faster, trouble-free service. Crose cleaning and priming machines are available for all sizes of pipe including 36".

m.j. Crose
MANUFACTURING COMPANY, INC.
2715 DAWSON ROAD • PH. MA 6-2172 • TULSA, OKLAHOMA
15225 EAST COLFAX AVENUE, AURORA, COLORADO • 500 FIFTH AVENUE, NEW YORK CITY
DISTRIBUTORS:
CROSE-CURRAN LTD., EDMONTON • CROSE PIPELINE EQUIPMENT CO., INC., NEWARK, N. J. • PIPELINE SUPPLY CO., HOUSTON

for that big one off shore

E-I-M

stands the Test...



It's just like fishing with a heavy test line when you install E-I-M Valve Controls. You can be sure that the well won't get away from you because E-I-M has a record of safety and dependability. Our engineers can solve your transmission problems with E-I-M Valve Controls for oil or gas lines off shore or across the continent.

The Pure Oil Company's platform in Bollivar Field, [illegible] miles off the Louisiana coastline, has four producing wells, each using an E-I-M Valve Control for maximum safety to protect personnel and the platform.

E-I-M *Company* INCORPORATED

1340 OLD SPANISH TRAIL • HOUSTON 25, TEXAS • MOhawk 4-4587

Valve Controls • Speed Reducers • Cooling Tower Drives • Control Valves

willing to put up enough money to pay for the thing.

"If the Trans-Canada management were overnight changed into 100 per cent fifth generation Canadians the facts of financial life are that most of the money they would use to build the line would still come from the United States because that's where adequate amounts of money for a venture of this kind are. Anybody—Canadians, Americans, Peruvians or Cypriots—will be very welcome to buy stocks and bonds in the enterprise.

"If the line were to be a sure fast profit bonanza, it would have been already built. The fact is it won't be. It will be a low interest rate affair.

". . . The pipeline is about the worse possible ground on which to take a stand against American capital in Canada."

Editorial in Financial Post, Toronto.

Plight of Small Business

"Stated quite simply in the expressive language of the senators, 'not enough of the bloom of 1955's industrial bonanza rubbed off on little business.' In too many cases, little businessmen got only the crumbs that fell from groaning tables of giants like General Motors, U. S. Steel, and Jersey Standard Oil.

"Since profits are the proof of the business pudding, the committee (Senate select committee on small business) assembled figures on 1955 earnings that cannot be easily shrugged off. In 1952, the report points out, small business managed to stay right on the heels of big business. In that year operators with assets under $250,000 earned, after taxes, a 10.6 per cent return on their investment. The biggest corporations, with assets over $100 million, did only a bit better, earning 11.2 per cent. In 1955, however, the relationship worsened considerably—big business earnings rose to 14.4 per cent return on investment, while the profits of little business dropped to 4.4 per cent return.

"If another yardstick of profitability is used—profits, after taxes, per dollar of sales—the committee reports that the same impairment in the relative position of little business is readily noticeable. In 1952, the smaller operators earned 2.3 cents per dollar of sales; the giant companies, 5.7 cents. During the first half of 1955, the earnings of small business dipped to 0.95 cent, while the earnings of the giants skyrocketed to 7.2 cents."

Bernard L. Majewski, president Great American Oil Co., Chicago, in address before Texas Oil Jobbers convention, Dallas.

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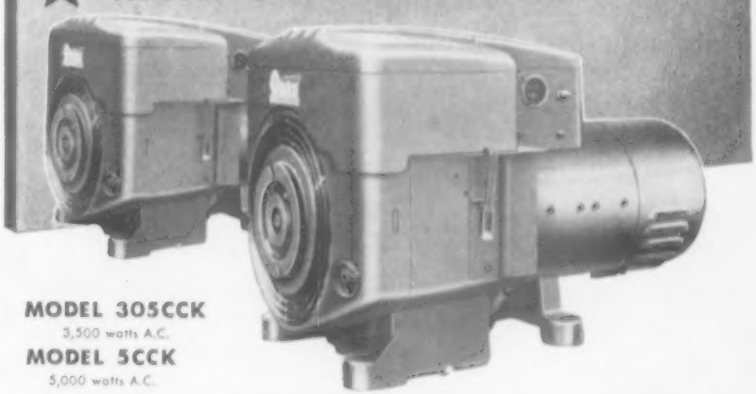

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CALENDAR OF EVENTS

APRIL

17 American Institute of Chemical Engineers, Philadelphia-Wilmington section—University of Pennsylvania, fourth annual meeting of "Experience in Industry" series.

17-18 Southern California Oil Industry Safety Conference, Long Beach.

17-19 Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, Okla.

18-20 American Petroleum Institute, Division of Production, Rocky Mountain District meeting, Cosmopolitan Hotel, Denver.

18-20 National Petroleum Association, semiannual meeting, Cleveland Hotel, Cleveland, Ohio.

19-20 Third Annual West Texas Oil Lifting Short Course, Texas Technological College, Lubbock, Tex.

23-25 Southern Gas Association convention, Dallas.

23-26 American Association of Petroleum Geologists and Society of Economic Paleontologists, annual meeting, Conrad Hilton Hotel, Chicago.

24-25 Pacific Coast Gas Association, Supply and transmission conference, Thunderbird Hotel, Las Vegas, Nev.

25-27 American Petroleum Institute, Division of Production, Eastern District meeting, Deshler-Hilton Hotel, Columbus, Ohio.

25-29 World Oil Exposition, Houston.

26 Panhandle Producers and Royalty Owners Association, annual meeting, Herring Hotel, Amarillo.

26-27 Eleventh Annual Management Engineering Conference, sponsored jointly by Society for Advancement of Management and management division, American Society of Mechanical Engineers, Hotel Statler, New York.

26-27 Rocky Mountain Oil and Gas Association, refining committee, ninth annual meeting, Newhouse Hotel, Salt Lake City.

29 May 1 Pennsylvania Petroleum Association, annual meeting, Bedford Springs Hotel, Bedford Springs, Pa.

30 May 1 Independent Petroleum Association of America, semiannual meeting, Statler Hotel, Los Angeles.

30-May 2 American Geophysical Union, thirty-seventh annual meeting, Washington.

30-May 5 International Course on Atomic Energy, sponsored by National Industrial Conference Board, Westchester Country Club, New York.

MAY

1-3 Petroleum Industry Electrical Association, annual meeting, Statler-Hilton Hotel, Dallas.

6-9 American Institute of Chemical Engineers, Roosevelt Hotel, New Orleans.

7-8 Gas Compressors Institute session, sponsored by University of Kansas and Southwest Kansas petroleum industry, Liberal, Kans.

7-11 American Welding Society, annual spring meeting, Hotel Statler, Buffalo.

9-10 Symposium on control of corrosion in

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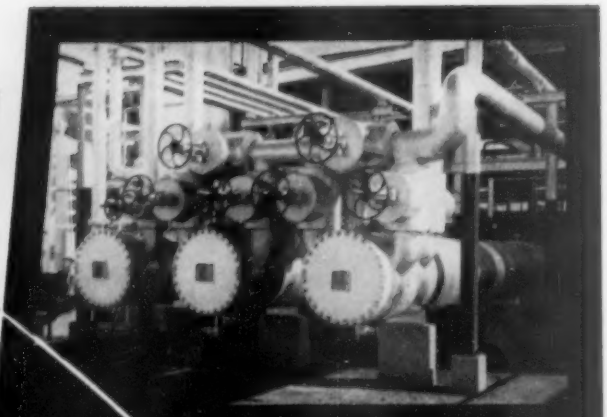

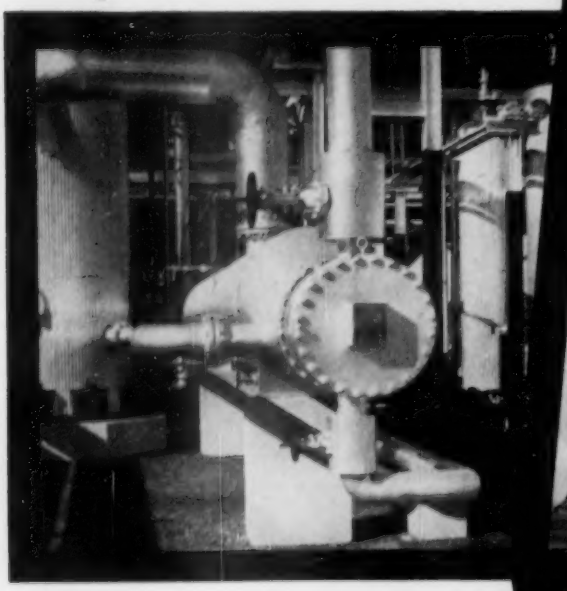

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Signal desires quotation on total exchangers for new gasoline plant near Ardmore, Oklahoma. April 1 delivery requested.

RATING AND PRICING JAN. 15-18 . . .

Complete quotation mailed to Hudson Engineering January 18.

REWORK AND REQUOTE JAN. 26 . . .

Changes in specifications received in the Western offices. Finished quotation mailed January 29.

FORMAL P. O. RECEIVED FEB. 1 . . .

Client's contractor, Hudson Engineering, gives go ahead for finished drawings for piping and setting.

WORKING DRAWINGS TO SHOP FEB. 17 . . .

Approved drawings turned over to shop for fabrication.

DELIVERY OF TOTAL EXCHANGERS APR. 2 . . .

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the chemical industry, University of Buffalo.

9-11 Canadian Institute of Mining & Metallurgy, Petroleum and Natural Gas division, seventh annual technical meeting, Palliser Hotel, Calgary.

9-10 National Association of Corrosion Engineers, Niagara frontier section, symposium on control of corrosion in the chemical industry, University of Buffalo.

10-11 American Petroleum Institute, Division of Production, Pacific Coast district meeting, Statler Hotel, Los Angeles.

10-11 American Gas Association, Gas Supply, Transmission, and Storage Conference, Conrad Hilton Hotel, Chicago.

13-15 Empire State Petroleum Association, Statler Hotel, Buffalo.

13-16 American Petroleum Institute, annual pipeline conference, Shamrock Hilton Hotel, Houston.

14-15 American Institute of Mining, Metallurgical & Petroleum Engineers, Kansas regional meeting, Broadview Hotel, Wichita.

14-16 American Petroleum Institute, annual pipeline conference, Shamrock Hotel, Houston.

14-16 Petroleum Electric Power Association, eighth annual convention, Robert Driscoll Hotel, Corpus Christi.

14-17 American Petroleum Institute, Division of Refining, midyear meeting, Montreal.

16-18 American Gas Association, Chemical, Engineering, and Manufactured Gas Production Conference, Benjamin Franklin Hotel, Philadelphia.

17-18 Rocky Mountain Petroleum Sections, American Institute of Mining, Metallurgical & Petroleum Engineers, Gladstone Hotel, Casper, Wyo.

22-24 Pennsylvania Gas Association, Pocono Manor Inn, Pocono Manor, Pa.

24-25 Natural Gas and Petroleum Association of Canada, Sheraton Brock Hotel, Niagara Falls, Ont.

24-25 Kentucky Oil and Gas Association, annual meeting, Lafayette Hotel, Lexington, Ky.

24-25 Western Petroleum Refiners Association, Michigan Regional Meeting, (location to be announced).

28-30 Chemical Institute of Canada, 39th annual conference and exhibition, Sheraton-Mount Royal Hotel, Montreal.

30-June 1 Texas College of Arts & Industries, eleventh annual short course in Gas Technology, Kingsville, Tex.

30-June 2 Interstate Oil Compact Commission, Dallas.

JUNE

3-8 Society of Automotive Engineers, summer meeting, Chalfonte Haddon Hotel, Altantic City, N. J.

6-8 American Society for Quality Control, tenth annual convention, Palais du Commerce, Montreal.

10-15 American Petroleum Institute, Production Division midyear standardization conference, Brown Palace and Cosmopolitan Hotels, Denver.

11-15 American Institute for the Advancement of Science, Gordon Research on Conference on Catalysis and Petroleum, Colby Junior College, New London, N. H.

13 Pennsylvania Grade Crude Association, thirty-third annual meeting, Bradford, Pa.

17-22 American Society for Testing Mate-

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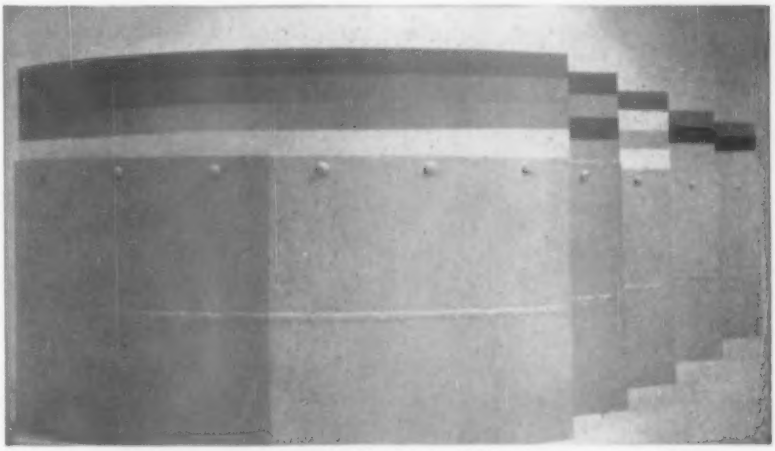

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rials, annual meeting, Chalfonte-Haddon Atlantic City, N. J.

17-23 World Power Conference, Vienna.

21-22 Western Petroleum Refiners Association, regional technical—industrial relations meeting, Broadview Hotel, Wichita.

21-23 American Association of Petroleum Landmen, annual convention, Denver.

26-29 Canadian Gas Association, Manoir Richelieu, Murray Bay, Que.

28-30 Rocky Mountain Oil and Gas Association, board of directors, Hotel Utah, Salt Lake City.

AUGUST

2-4 Rocky Mountain Mineral Law Foundation, Second Annual Institute, University of Colorado, Boulder.

SEPTEMBER

11-13 Pacific Coast Gas Association, annual meeting, Coronado, Calif.

13-15 Chemical Institute of Canada, third Western Regional Conference, Edmonton, Alta.

17-21 Instrument Society of America, eleventh annual international instrument-automation conference and exhibit, New Coliseum, New York City.

20-21 Western Petroleum Refiners Association, regional technical-industrial relations meeting, Hotel Henning, Casper, Wyo.

20-21 Mid-Continent Oil and Gas Association, Louisiana-Arkansas division, annual membership meeting, Roosevelt Hotel, New Orleans.

24-26 American Society of Mechanical Engineers, petroleum mechanical engineering conference, annual meeting, Statler-Hilton Hotel, Dallas.

26-28 Rocky Mountain Mineral conference, American Institute of Mining, Metallurgical & Petroleum Engineers, Newhouse Hotel, Salt Lake City.

OCTOBER

2-3 Texas Mid-Continent Oil and Gas Association, thirty-seventh annual meeting, Rice Hotel, Houston.

7-9 American Association of Oil Well Drilling Contractors, annual meeting, Texas Hotel, Fort Worth.

14-17 American Institute of Mining, Metallurgical & Petroleum Engineers, Petroleum Branch, fall meeting, Biltmore Hotel, Los Angeles.

15-17 American Gas Association, annual meeting, Atlantic City, N. J.

18-19 Western Petroleum Refiners Association, regional technical-industrial relations meeting, Rufus Garrett Hotel, El Dorado, Ark.

22-24 Rocky Mountain Oil and Gas Association, annual convention, Cosmopolitan Hotel, Denver.

29-Nov. 1 Society of Exploration Geophysicists, national convention, New Orleans.

NOVEMBER

7-8 Philadelphia section, Instrument Society of America, Symposium on Process Data Logging, Stratford Hotel, Philadelphia.

12-15 American Petroleum Institute, annual convention, Conrad Hilton Hotel, Chicago.

19-20 American Institute of Mining, Metallurgical & Petroleum Engineers, North Texas Secondary Recovery Symposium, Municipal Auditorium, Wichita Falls.

25-30 American Society of Mechanical Engineers, Statler Hotel, New York.

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JOURNALLY SPEAKING . . .

Loss of a Friend

THE Journal has lost one of its oldest and most loyal readers.

Ernest James Nicklos, perhaps the last charter subscriber to the Journal, died in a Houston hospital April 7 following a 7-week illness.

His death saddened the hearts of hundreds of friends and fellow oil men who had known and respected him during the 59 years in which he helped mold the oil industry of today.

The Journal will feel his loss even more keenly than will the industry as a whole. For E. J. Nicklos, chairman of the board of Nicklos Drilling Co. and Nicklos Oil & Gas Co., represented the type of readership on which the Journal has based its reputation for more than 53 years. Without the confidence which E. J. Nicklos and a few other pioneer readers placed in the infant Journal, the Big Yellow Book might not exist today. Certainly it wouldn't have remained the dominant voice in the oil industry for more than half a century without such loyalty.

We can speak freely of the man's devotion to the Journal now only because he himself spoke so freely of it in the past.

An interviewer, making one of the periodic readership surveys for the Journal, recently quoted Nicklos as saying: "I have been reading The Oil and Gas Journal since its inception and am sure I have received as much benefit from it as almost anyone who has read it as long as I have."

His secretary recalls that Nicklos laid his work aside each week when the Journal arrived. "That was the first thing he looked at when his mail came," she says.

But this mustn't be a sentimental epitaph. Nicklos wouldn't approve.

Nicklos was from the old school. He didn't like for such things as death or sickness to slow down his rigs. In accordance with that tradition, his office was open for business the day of his funeral. Staff members worked as usual until a few minutes before leaving for services.

Born in Ontario, Canada, August 29, 1880, Nicklos grew up with the oil industry. His father, the late Charles Nicklos, operated a refinery at Petrolia, Ont.

At the age of 16, E. J. Nicklos started working during school vacations in the oil fields and refinery under supervision of his father. When he was 21 he went with his father to Galicia, Poland, where the elder Nicklos had the assignment to build that country's first modern refinery.

In 1901, while in Galicia, young Nicklos joined the firm of Bergheim & MacGarvey as a production worker. At the age of 23 he became drilling superintendent in Croatia.

After working in European oil fields for 8 years, Nicklos became superintendent and manager of Anglo-Mexico Oil, Ltd., at Tampico, Mexico. In 1913 he entered the drilling business there as an independent. He left Mexico 9 years later to become division manager of production for The Texas Co. in Oklahoma, Kansas, and Kentucky. In 1928 he joined Continental Oil Co. as vice president in charge of production.

E. J. NICKLOS

Nicklos resigned from Continental in 1935 to move to Houston, where he became an independent operator.

His son, Gordon E. Nicklos, is vice president of Nicklos Drilling Co. Also surviving are the widow and a daughter, Mrs. Robert W. Baker, Tulsa. A brother, John Nicklos, also a veteran oil man, died in 1954.

By an odd twist of irony, the Journal had planned to interview Nicklos and to publish a story on his recollections of the magazine back in the days when it was still known as "Oil Investors' Journal." But when the correspondent called for an interview, Nicklos already was in the hospital.

We're sorry we didn't get to print the story. Perhaps through it Nicklos would have got some inkling of how highly we regarded his friendship.

—*Joe Reilly.*

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Natural's future may lie in its components

FUTURE progress and prosperity for natural-gas liquids depend on much more intensive processing and fractionating, according to one school of thought. This would permit the various components of the now-mixed hydrocarbons to be tailored to individual markets.

This belief is based on two premises: Most of the products of field processing plants usually sell below their economic value in terms of heat and chemical content; and present markets are unlikely to expand as fast as the probable increase in production.

The theory is that each separated component would find a specialized market in fuel blending, petrochemicals, or other uses. And that their combined price would be sufficiently above present levels to more than pay for the difficult fractionating and reforming processes.

ON THE OTHER HAND, many operators of field processing plants look on this idea as something of a pipe dream. They don't consider themselves in the petrochemical business, and they take a dim view of the expensive equipment and intricate technology which would be required.

They point with concern to the difficulties of building markets for relatively new chemicals and hydrocarbon fractions, and particularly to the high cost of transportation from scattered and remote field plants. The game doesn't seem worth the candle.

These operators would be glad to have others purchase their output as raw material for specialty products, but for themselves they see their salvation in plugging harder along accustomed lines. They hope to promote greater use of propane in internal-combustion engines and for farm and rural domestic fuel. They hope to induce refiners to blend more natural gasoline and butane in motor fuel—and to induce automobile designers to encourage this.

BUT THE HISTORY of the petroleum industry as a whole supports the first view. Today's motor gasoline is a complex chemical, and the modern refinery is virtually a petrochemical plant. The trend is inexorably toward greater refinement and reformation of hydrocarbons for all purposes. And the whole petrochemical industry is based on isolation and rearrangement of petroleum molecules.

It would seem a safe bet that the fastest-growing market for natural-gas liquids in the next few years will be for their fractions and derivatives. And whoever does the necessary processing stands to reap the potential profits.

Those field processors who, by pooling their efforts or otherwise, can devise ways to surmount the investment, transportation, and marketing problems have a bright opportunity to get into the petrochemical business. Those who don't may have to be satisfied with producing a crude material for other plants to upgrade to the needs of ultimate consumers.

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Yet down-time is short with Stratafrac. Liquid materials arrive at the well already mixed. Treatment is fast with minimum shut-in afterwards, and no gel breaker needed.

Stratafrac's unusual flexibility makes it effective in almost all types of formations. To match well conditions, Dowell engineers can vary acid and sand content, or add silicate control and clay dissolving agents. This double-action Dowell treatment has brought outstanding, *sustained* production increases to wells in almost every area.

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The Industry This Week

Pipelining

• **Trans-Canada** may have major-league opposition. A new combine headed by Frank H. McMahon of Westcoast Transmission reportedly is offering to build an all-Canadian line without government help and to export 400,000 M.c.f. of Alberta gas into the U. S. Midwest. P. 120.

A 15 per cent expansion is being planned for West Texas Gulf Pipe Line Co.'s major crude line from West Texas to the Gulf. P. 129.

Processing

• **High octanes are complicating** the charge-stock picture for petrochemical makers. Higher-octane materials soon may be out of their price reach. They already are studying other hydrocarbons as possible raw materials. P. 134.

Olefins may fit into this petrochemical picture, thanks to a development announced by Carbide & Carbon Chemicals. They are expected to become the charge stock for a whole new field of epoxy chemistry. P. 121.

Exploration

• **Wyoming's Pacific Creek structure,** once condemned by a 20,521-ft. dry hole, will be tested again. California Co. geologists think promising formations in the big anticline may have been bypassed. Calco plans a 13,000-ft. Mesa Verde test. P. 126.

Union Oil is getting ready to offset its 1 Cocoles producer which is expected to prove Costa Rica's first oil well. P. 138.

Importance of the Devonian trend in Northeastern Lea County, N. M., is emphasized by another strike. The Ralph Lowe 1 Wallace flowed at a rate of 2,640 bbl. of 46°-gravity oil a day. P. 133.

Production

• **A new reservoir-limit test** has been designed to take part of the guesswork out of reserve estimates on new discoveries. It means a wildcatter can tell how much oil or gas is connected to his well. This will guide him in offsetting or buying more leases. P. 124.

Greater production from new wells at lower drilling and completion costs has been achieved by using a water-in-oil emulsion drilling mud devised by Pure Oil. P. 128.

Industry

• **Magnetic recording poses a dilemma** for seismic contractors. The widely heralded recorders provide a more useable record. But their high cost prevents even large contractors from making money on them at present contract prices. And some small contractors say they may be squeezed out of the picture. P. 118.

Electronic computers are paying off in speeding design and operating calculations in natural-gasoline plants. They result in faster, more accurate results with less manpower. P. 132.

Conservation

• **Unitization of the big, complex Seeligson field** of South Texas is being tried. Major operators have signed an agreement covering most of the field. Pressure maintenance will involve injection of 150,000,000 cu. ft. daily of gas and large volumes of water. P. 125.

Another try at strengthening Colorado's conservation law will be made. The state's conservation commission will present changes to the legislature next year. The aim: to stop gas flaring. P. 137.

Magnetic Recorders Pose Cost Problems

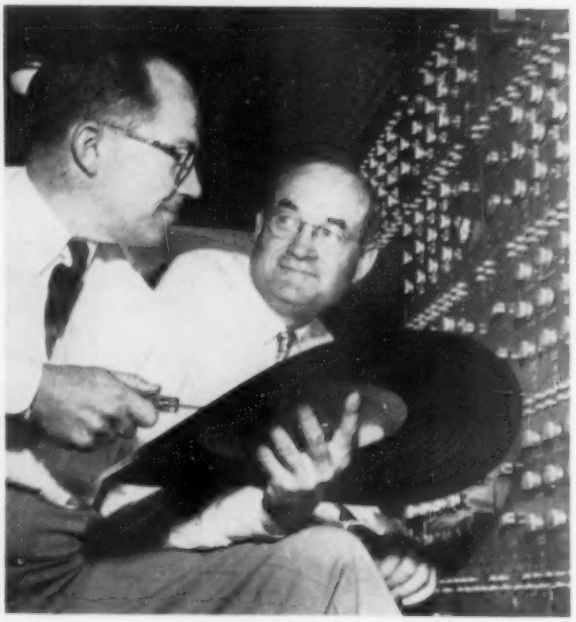
● Small geophysical contractors claim they can't afford new tool while bigger firms say they aren't making money with it

Gene T. Kinney

THE seismograph industry is finding that progress can be both a blessing and a curse.

That is the case with the most widely heralded new tool developed for geophysicists in recent years—the magnetic recorder. The advent of broadband recording, providing a permanent record of all available seismic energy recorded in the field, is considered a major technical advance.

But its economic impact has perhaps been even more profound. While more usable seismic records are a potentially great boom to oil finding, the new tool has been something less than lucrative to contractors. The greatly increased equipment outlay has the larger contractors wondering how it's going to pay for them, and the small ones wondering whether they can stay in business.



R. W. Olson, left, president of Houston Technical Laboratories, and C. H. Green, chairman of Geophysical Service, Inc., examine a record produced by H. T. L.'s magnetic-recording system.

Economic reception . . . Economically, the contractor is finding the new instrument more of a curse than a blessing at the present time.

The cost of putting magnetic recorders in the field is about double that of present equipment. And the return is not big enough to pay for the added expense.

Virtually no small contractors have magnetic recorders. The thin profit margin of the operator running half a dozen crews or less makes it impossible for him to convert.

The large contractors who are adding the recorders to their trucks are almost unanimous in saying that they aren't making any money on them. In fact, they expect the equipment to wear out or be made obsolete by improvements before it is depreciated.

Most feel that magnetic recording is the coming thing and they don't want to be left behind. The major contractor is getting aboard the bandwagon because he cannot afford not to offer the improved service if he is to maintain his position in a fiercely competitive industry. He also may want to get the jump on competitors by setting up a central playback center to handle field reports of oil companies and other contractors.

Scientific reception . . . Like most new things, magnetic recording is being accorded a mixed reception.

Geophysicists are widely divided as to what its merits are. Their opinions run the gamut from one extreme to the other. Many go so far as to acclaim it as a universal cure-all, the potential answer to "no records" areas.

Skeptics and pessimists comment that it's not all it's cracked up to be, and magnetic recording won't do anything that isn't already being accomplished with present equipment. The latter view is taken by a major oil company which is nonetheless using a couple of crews equipped with recorders and is doing research, "just in case."

In the middle are those who say that the value and place of magnetic recording in seismic exploration remain to be established.

The rub . . . The high cost of broadband recording and the split scientific opinion combine to produce a dilemma for contractors.

More and more companies are asking for magnetic-recorder-equipped crews for specific jobs. Generally speaking, they are sold to the extent that they think the recorders are a definite improvement. But they aren't sold enough to want to pay what the contractors claim is necessary to justify their purchase and the addition of more highly skilled personnel.

And any piece of equipment that doesn't earn its way and make a profit has no permanent place in their operations, the contractors contend.

So what do they do?

The larger contractors take the plunge and convert a few crews to magnetic recording. One contractor with a manufacturing tie-up has a couple of dozen in the field, but that is a notable exception. The conversion is made on the theory that they are raising the quality of their service. As technical improvements are made in the various recorders, and as their merits become more obvious and more of their potential is realized, contractors expect to get a better price for them.

Meanwhile, they are gaining valuable experience.

The small contractors are left on the outside looking in.

Budgets upset . . . The purchase of magnetic recorders has played havoc with budgets.

Contractors estimate that the cost of putting a magnetic recorder into a field truck will run about $25,000. If the truck instruments are obsolete, the cost of new equipment and the recorder, too, will be nearer $50,000. Then the playback unit adds $25,000.

A contractor with three seismic field parties faces a bill of some $100,000 to convert completely to magnetic recording.

One company which is buying four recorders and two playbacks shelled out $200,000. That's 2½ times as much as would have been required to put four trucks in the field with standard equipment.

One of the biggest contractors with

crews operating all over the globe reports its equipment investment for the first 6 months this year is double the entire 1955 figure. Almost all of the increase was blamed on magnetic recorders and related equipment.

The situation is further complicated by the many different types of magnetic recorders now on the market. There is no single playback that will handle records from all magnetic units.

The advantages . . . Geophysicists envision all manner of benefits from magnetic recording.

But its basic advantage is that it provides a permanent record over the entire range of useable seismic frequencies. It is not limited by the filter setups of individual trucks.

With conventional instruments, the interpreter is at the mercy of the field observer who makes the decisions on filter settings and what frequencies to concentrate on. Only a limited range of data is recorded.

Today, the seismic survey may be geared to mapping a shallow formation. The geophysicist and geologist are interested only in the shallow, high-frequency reflections. The deeper data is ignored.

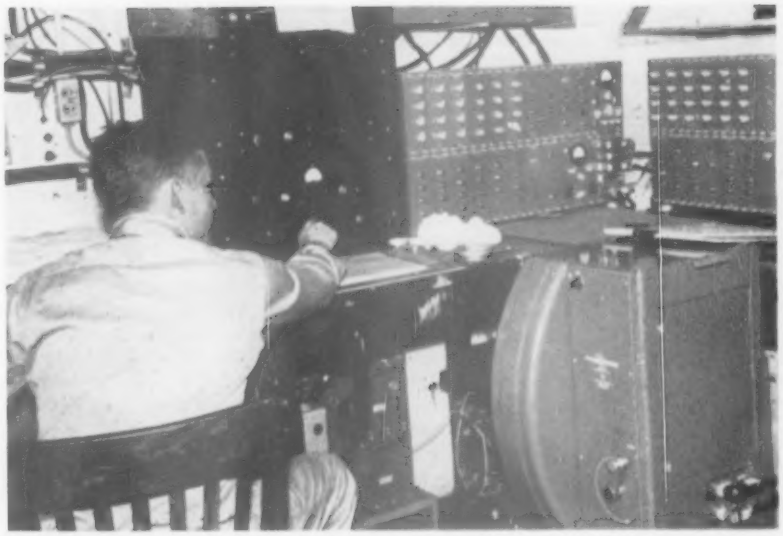
Tomorrow, deep drilling could reverse the exploration thinking and make the deep, lower-frequency energy of prime importance. With magnetic recording, both types of energy are presented on tape or disc. The record can be played back time after time to extract all the usable information.

The shallow energy can be analyzed, using one filter setting. Then the magnetic record can be replayed with a different filter setting that will accentuate the deeper reflections.

Oil companies see magnetic recording as a money-saver in some areas where a single shot with ordinary equipment cannot supply enough data. With a magnetic recorder, there would be no need to redrill a collapsed hole for additional shooting. It would be ideal in remote areas or locations which are expensive to reach.

As one company executive remarked: "You don't relish going back to the Sahara Desert for additional shooting because you need more data. Magnetic recording should eliminate much of this reshooting."

Some oil companies expect to use magnetic recorders primarily to increase the efficiency of shooting with conventional equipment. The field observer can determine the best filter setting for a given area by replaying the magnetic record. This setting can then be used by crews to shoot the area with the less expensive conventional instruments.



MAGNETIC EQUIPMENT is being used by Geophysical Service, Inc., in seismic work offshore. The disc-type recording unit is one of several different makes now in use.

Autocorrelation . . . Research is already being pressed toward the goal of electronic correlation of records with the aid of magnetic tape or disc.

The correlation for weathering, elevation, and other factors can be made for each trace on the seismic record. This part is already handled by movable playback heads.

But in the future, some scientists expect corrected records to be matched up with adjacent records by using electronic computers. Once the records are matched up or correlated, it will be a fairly simple matter to reproduce the matched data on light sensitive paper. The final product will be a cross section plotted either in terms of time or feet.

The oil finder can then plot the well control on the cross section and make his geologic interpretation directly on the cross section. The Reynolds plotter is a step in this direction without the use of magnetic records. But with magnetic records, geophysicists hope to reach the goal of autocorrelation.

Some early investigations have been discouraging, but widespread effort is still being devoted to the problem.

Magnetic recording tomorrow . . . Though in its infancy, magnetic recording is riding the crest of a boom that has seen enough sets sold to equip one out of every five seismic crews operating in the world today.

There is no question but that it will become increasingly important in seismic exploration. One major oil company expects its own crews to be converted in 3 to 5 years. More companies are expected to require magnetic recorders on contract crews, too.

Some contractors, large and small, are already losing out on jobs where clients demand magnetic recorders. As broad-band recording gains wider acceptance, they expect the squeeze to become tighter.

To this point the situation is not too serious. The reason is that higher exploration budgets are providing enough business to go around. But a cutback, in the opinion of some small but competent contractors, could bring them face to face with bankruptcy.

One contractor who has three crews says he's "itching to go to magnetic recording," but adds: "I don't want to bad enough to go broke doing it. And right now, with what you can get for a magnetic recorder, I'd rather quit business than buy one."

Another mentioned losing a contract because a client insisted on a magnetic recorder. Yet the company would not guarantee even a year's work.

"With a deal like that, you couldn't possibly come out," the contractor remarked. "The only way I could consider buying a recorder now would be to have a 2-year contract guarantee. Maybe in that time it would almost pay for itself."

The larger contractors see no danger that magnetic recording will force any but marginal operators out of business. There will always be a certain amount of business, they say, in simple areas where conventional records will supply all the data needed.

All agree on one point. They must get more for their crews or pay less for magnetic-recording equipment, or both. When that time comes, one small contractor says, he'll convert, too—"if I'm still around."

Trans-Canada Has New Foe

Westcoast combine offers to build all-Canadian gas line without government help and export fuel to U. S. Midwest

CALGARY.—A major rival suddenly has appeared to contest with Trans-Canada Pipe Line Co. the right to build an all-Canadian line and export natural gas into the U.S. Midwest.

Frank H. McMahon, Alberta multimillionaire, is reported heading a group which offers to build the West-East line across Canada without government help. McMahon is president of Westcoast Transmission Co. and Pacific Petroleums, Ltd. The deal would involve sale of 400,000 M.c.f. daily of gas to three U.S. gas distributing companies for resale in the Midwest.

The development came as Trans-Canada and Tennessee Gas Transmission Co. pressed their request before the Federal Power Commission in Washington for permit to import Canadian gas into the U.S. Trans-Canada already has authority from the Canadian Government to build the long-stalled pipeline and a permit from the Alberta Government to export 200,000 M.c.f. daily to the U.S. through an affiliate of T.G.T.

Key to the Trans-Canada plan is an agreement by the Ontario and Canadian governments jointly to finance an uneconomic leg of the line across northern Ontario.

The rival plan . . . McMahon has presented to Canadian officials a plan to build the line without participation by the government. Financing would come through U.S. investment houses, insurance companies, a Canadian bank loan, and sale of shares to McMahon interests, which would hold control.

Long-term contracts would be made with a group of U.S. firms for sale of 400,000 M.c.f. daily of the Alberta gas. This group includes Northern Natural Gas Co., Michigan Consolidated Gas Co., and American Gas Co., all bitter foes of the Trans-Canada-T.G.T. combine.

McMahon's group still has a long road to travel. It must get sufficient reserves allocated from the Alberta Petroleum and Conservation Board, win permit of the Canadian Government for the line, and get FPC approval to import the gas.

The strategy . . . Oil men in Canada and the U.S. see in McMahon's sudden move an attempt to head off FPC approval of the T.G.T.-Trans-Canada import request. This would give the McMahon group time to firm up its proposal and win support for it among Canadian officials and politicians.

They point out McMahon knows Trans-Canada is having its troubles and hopes to capitalize on the offer to build the line without involving government help. But the same troubles haunting Trans-Canada might face McMahon.

Main cause of Trans-Canada's present situation is the nationalistic feeling in Canada now against domination by U.S. capital. Trans-Canada's proposition has been supported by the Liberal Party and this makes the company a "sitting duck" for accusations by Conservatives that it is overloaded with American money. But much of McMahon's financing also would come from the U.S. and he would be subject to the same attack.

Trans-Canada only after long and painful efforts won approval to build the line and export gas to the U.S. It doesn't have FPC approval to bring gas in. McMahon may have to travel the same painful route. It took more than 2 years for his Westcoast Transmission and Pacific Northwest Pipe Line Co. to win final approval for their plan to move Peace River gas down into the U.S. That big project only now is under way. First deliveries are scheduled for November 1957.

The upshot of the development is that T.G.T.-Trans-Canada now is facing organized major opposition in Canada as well as the U.S.

A group of U.S. midwestern gas firms has been fighting T.G.T.'s plan to bring the Canadian gas through their territories. The battle has spawned at least two alternate pipeline proposals to supply the Midwest with Canadian gas by another route or to bring in gas from the U. S. Rockies.

Navy Soothes San Nicolas Foes

WASHINGTON.—Domestic producers, fearful that the Navy's search for additional oil reserves will bring new competition, last week got a word of reassurance from Washington.

Department officials made it clear they have no intention of going into the oil business. The planned test of San Nicolas Island off the coast of California is a search for insurance against a future emergency. It is not aimed at immediate production, they said.

The Navy asked Congress last month for $529,000 as a start. Plans are to drill a core hole and an exploratory well to test a long-held belief the island sits on an oil field *(The Oil and Gas Journal, March 19, page 132)*.

Present planning stops at San Nicolas. But if oil is found in volume, the search may be extended to the adjacent Navy-owned islands of San Miguel and San Clemente. The Navy would like to come up with another really worthwhile reserve on the West Coast.

The objections . . . Disclosure of the Navy's aims brought immediate adverse reaction from at least two producers groups.

The Oil Producers Agency of California blasted the plan as "an unwarranted invasion of the private rights of citizens, and an unjustifiable spending of taxpayers' money." Further, the agency charged, it is contrary to sound economics and sound public policy.

The Western Oil & Gas Association asserted the island is public land and should be developed under the Mineral Leasing Act.

Last week Under Secretary of the Navy Thomas S. Gates, Jr., met the producers' criticisms in a letter to R. R. Von Hagen, president of the California agency.

Navy explanation . . . The Navy has been under a congressional order to find new reserves since 1948, Gates explained. San Nicolas was selected for the present effort because of "its strategic location, the fact that it is wholly owned by the Navy, and offers no problem as far as prospective drainage or involvement in unitization agreements are concerned," he said.

Industry's distrust of Government oil activities dates back to the mishandling of the reserves in the early 1920's. But after the Teapot Dome scandal Congress tightened up the government's oil policies.

While Teapot Dome failed to come up to expectations and is considered practically worthless, and the shallow zone of Buena Vista is leased to private operators, Elk Hills has been developed as a standby source of 100,000 to 150,000 bbl. a day for emergency use. Any new reserves secured would be treated the same as Elk Hills.

The Navy is the only federal agency now allowed to explore for and produce oil and gas. It is limited, however, to lands in the naval petroleum reserves or areas set aside for naval uses.

Olefin Values on Rise

Refiners may find outlet as petrochemical charge stock for this problem child as result of Carbide discovery

NEW YORK—Petrochemical manufacturers may be looking around the refining industry for more olefins to be used as basic charge stocks in the next several years.

This prospect was opened last week by Carbide & Carbon Chemicals Co. It stems from a successful research program which now opens the possibility of an entirely new field of oxidized chemicals.

Carbide has developed a process for making peracetic acid from acetaldehyde. This new process also produces acetic acid with yields comparable to those obtained in the conventional process widely employed in making acetic acid. But it produces a bonus in peracetic acid, which is a key material in epoxy chemistry.

In the past, the production of epoxides has been restricted largely to the lower compounds like theylene oxide and propylene oxide. Until now, it was not economically possible to oxidize the higher hydrocarbons. Through the use of peracetic acid, however, it is possible and practical to epoxidize almost any unsaturated compound. Carbide has made a total of 375 of these higher epoxides already.

From the standpoint of future end uses for this new class of chemicals, the field appears to be open in making plasticizers, resins, coatings, surfactants, pharmaceuticals, odorants, and probably other product types.

Market research is now under way, and Carbide is offering peracetic acid to outside research laboratories for development of new chemicals. While peracetic acid will find its greatest use an an intermediate, it has established uses as a germicide and bleach.

What it means . . . The refining industry, being the greatest producer of olefins, will be interested in this new development as offering a new outlet for unsaturated hydrocarbons.

In this early stage of development, Carbide is much interested in butadiene, diisobutylenes, styrene, and other basic chemicals from petroleum, which readily react with peracetic acid to produce epoxides.

There appears to be no limit to the range of petroleum-derived olefins which can be used in this synthesis process.

Carbide research has shown that peracetic acid is not only highly reactive with olefins, but the reaction is selective in nature. In a mixture of several olefins for example, peracetic acid will react selectively with certain olefins and isomers at specific temperatures. The epoxidized compounds can then be separated out, whereas the fractionation of the reacting olefins from the original charge might have been difficult or impractical. This makes the synthesis of specific oxidized compounds possible without expensive feed selection.

Refiners whose olefins are beginning to become problems in making high-octane gasoline may find some new outlets for these large volume basics. Their stake in the new program will depend on what new chemicals develop and what markets they will attract.

For the present peracetic acid is available only in pilot plant quantities. But Carbide is well along on plans for a commercial unit which will probably be built at South Charleston. Assuming that this new intermediate commands the position expected by Carbide, it can be made in large volumes at a reasonable cost. The petroleum industry may figure largely in this promised new field as the major supplier, if not an important producer, of finished epoxy chemicals.

Bureau Creates New Refining District

REPORTS of refining operations by the Bureau of Mines now include a new district.

Starting with the first of the year, the bureau created another refining district by combining North and South Dakota from Mid-Continent with Minnesota and Wisconsin from the old Indiana-Illinois-Kentucky district.

The map shows the new district and outlines of other refining areas. The boundary line between East Coast and Appalachian 1 runs along the western edges of Cayuga, Tompkins, and Chemung counties in New York and Bradford, Sullivan, Columbia, Montour, Northumberland, Dauphin, and York counties in Pennsylvania.

The western boundaries of the following counties form the dividing line in Ohio between Appalachian 2 and the Illinois-Indiana-Kentucky districts: Erie, Huron, Crawford, Marion, Delaware, Franklin, Pickaway, Ross, Pike, and Scioto.

The Texas Gulf Coast district includes these counties: Newton, Orange, Jefferson, Jasper, Tyler, Hardin, Liberty, Chambers, Polk, San Jacinto, Montgomery, Harris, Galveston, Fort Bend, Waller, Brazoria, Wharton, Matagorda, Jackson, Victoria, Calhoun, Refugio, Aransas, San Patricio, Nueces, Kleberg, Kenedy, Willacy, and Cameron.

Louisiana Gulf Coast district includes the following parishes in Louisiana and all parishes to the south: Vernon, Rapides, Avoyelles, Pointe Coupee, W. Feliciana, E. Feliciana, Tangipahoa, and Washington.; also, these counties in Mississippi: Pearl River, Stone, George, Hancock, Harrison, and Jackson; plus Mobile and Baldwin counties in Alabama.

Critical Question in California:

Should a Conservation Law Be Adopted?

ABSOLUTELY! says Richfield Oil Corp.'s R. W. Ragland.

DEFINITELY NOT! says Union Oil Co.'s A. C. Rubel.

For the first time in 17 years and the third time in the state's history, Californians will decide November 6 whether to adopt a conservation law. A bill drawn up by Richfield Oil Corp. and supported strongly by Shell Oil Co. and General Petroleum Corp. will be the subject of the referendum. The proposal is opposed, among the majors, by Union Oil Co. Last week in Bakersfield prominent spokesmen for both views debated the issue before the San Joaquin Valley Oil Producers Association. The ball was carried for the proponents by R. W. Ragland, Richfield vice president and a co-sponsor of the conservation bill with C. S. Jones, Richfield president. Speaking against the bill was A. C. Rubel, vice president of Union. Presented here are accounts of both speeches.

BAKERSFIELD.—The only division within the oil industry over the conservation bill will be between those who want all they are entitled to and those who want more than their share, with no regard for the public interest, R. W. Ragland told the San Joaquin producers.

"None stand to lose except the freebooter who will lose the opportunities to seek selfish advantage. The difference will be between right and wrong. It will be just that simple," Ragland said.

Ragland described a recent statement by Reese Taylor, president of Union Oil Co., which attacked the proposed law, as "a masterpiece of concentrated chicanery," and "a studied effort to perplex the issues and obscure the truth.

"Experience has taught the industry that it cannot get along without rules of the game and without an umpire," Ragland said in urging the association's support of the measure which comes up for a vote in the November elections.

"Since regulation is necessary," he said, "Let's have regulation under the sanction of law, binding on everybody at all times. Only if the California oil industry persists in refusing proper regulation by the state need we fear control by the state."

Reserves would double . . . Ragland said a conservative estimate of the effectiveness of the proposed act is that it would double the state's present recoverable reserve of 4

BAKERSFIELD.—"I say it is a control bill in every sense of the word and likewise a compulsory unitization bill.

"This bill puts the state government in the middle of your oil business. It would force independent oil operators to surrender their God-given independence to run their job in the traditional American manner for a system of bureaucratic controls.

"These will be administered by a politically appointed three-man commission, whose authority is limited only by a vague uncertain definition of "waste" and good engineering practices."

"There has been no demand for statutory control from either within or without the industry, except for the sponsors of the measure," Rubel declared. "No such laws were needed in the past, and they are not needed now. Existing regulations provided by the legislature are adequate.

"That these laws have been successful is proved by the fact there has been less gas blown to the air per day in the entire state during the past 10 years than in any one of many individual pools in the states of Texas, New Mexico, or Louisiana. The statute pertaining to underground wastage has likewise proven effective in recent litigation.

"The combination of the Conservation Committee of California Oil Producers and the statutory authority of the division of oil and gas provides for everything we need properly to safeguard the present and future of our production."

What Ragland said . . .

billion barrels. He stated the act was necessary as a legal tool to match industry technology.

He stated that the conservation act is designed to prevent primary waste and waste that occurs when producers fail to recover oil that could be produced by unitization and use of secondary-recovery methods. The act clearly defines waste occurring in relation to primary recovery, Ragland said, and sets up a three-man conservation commission to make orders necessary to prevent that waste as defined in the law.

Ragland hit the present system under California law. He contrasted the proposed new law with the old "which gives the State Oil and Gas Supervisor unlimited and undefined power to fix gas-oil ratios." He further claimed, that in contrast to the state-supervisor system, the new law would eliminate possibility of discrimination between different properties in the same pool. The Conservation act provides that the rights of all owners in a pool must be protected so each will receive his fair share of the oil.

Ragland defended the compulsory unitization features of the new measure. Such unitization, he pointed out, can be attained only if 75 per cent of the operators and landowners agree to a plan, and only if the plan is judged fair and profitable to 100 per cent of the interest in the field. This is the same fundamental law that provides that the constitution of the United States can be amended only if 75 per cent of the states ratify the amendment, he added.

Fair production rates in a unit agreement would protect against both too — low and too — high production, he asserted. Nothing in the act permits either the commission or the courts to make or enforce orders restraining production to an amount less than can be produced without waste.

Opposition criticized . . . In blasting Taylor's statement in the report to Union stockholders, Ragland noted that Taylor claimed that 24 per cent of California production comes from some form of voluntary unitization. This, Ragland said, is completely misleading because it includes some 13 per cent of the state's production coming from partially unitized fields.

"In order to reap full benefits of unitization not a single producing property can be left out," Ragland told the Valley producers' group.

Ragland also hit at Taylor's statement that major companies hold 75 per cent interest in a majority of the important California fields. Ragland said that in five of the six largest fields the combined interests of majors ranges from 9 per cent to a high of 58 per cent. He added that "of the 180 most important fields, the major companies hold over 75 per cent in only 45 fields, while independents hold over 75 per cent in 67 fields.

"Opponents cry that majority rule unitization involves confiscation of property of the minority. On the contrary," Ragland said, "something much closer to confiscation is involved when a majority are prevented from full enjoyment of their property rights by a minority."

Under unit operation, he continued, each separately owned property in the unit "shares in every barrel of oil and every cubic foot of gas produced from the pool as a whole for the entire life of the pool."

Ragland emphasized that the rule to share in the total recovery would apply even to units where no production occurs. Allocations would be based on "the value of each property for oil and gas purposes" and its relative contributing value to the unit.

The proposed commission would decide whether allocations were fair to each property in a unit.

What Rubel said . . .

Economic need lacking . . . The so-called "conservation" laws of other oil states are primarily "control" laws to regulate production to market demand, he stated.

But California lacks approximately 130,000 bbl. a day of being able to produce its requirements. Therefore there is no reason for any control of its production for such purposes, Rubel explained.

Discussing another point of the major arguments advanced by sponsors of the measure, Rubel declared:

"It is charged that California oil men are operating in an inefficient manner which wastes our natural resources. The truth is that California oil men are drilling and producing the petroleum resources of our state in a manner equal in efficiency to any group of operators in the country. We are far ahead of most states in the application of modern technology."

By resorting to initiative-type legislation and requiring that any changes to the measure can be made only by further initiative action, Ruble said, "we will be freezing into law rules and regulations for the future conduct of the oil industry on the basis of our present very incomplete knowledge.

"Practices and techniques deemed highly efficient today might well be looked upon as obsolete next year. And yet this measure to a large degree writes permanent ground rules."

Provisions of the proposed measure for unitizing oil fields he called "compulsory, regardless of what sugar coating may be applied." In a majority of California fields, holdings of a few of the larger companies constitute the necessary 75 per cent working interest to force a unit agreement, he pointed out.

"This is neither fair, just, nor in the best interests of the public or the oil industry. If a unit plan cannot be formulated which can be sold to the operators of a pool on its own merits, then something is wrong with the plan. To force the operator into such an agreement against his will is plain confiscation."

Unitization already working . . . California operators already are keenly aware of the value of unit operations, Rubel pointed out, saying:

"There are operating currently in California 12 fully unitized fields producing a total of 45,628 bbl. daily. Seven partially utitized pools produce 104,884 bbl. daily. Fifteen other fields under operating agreements or operated by a single company produce 89,065 bbl. daily. The total of 239,577 bbl. represents about 25 per cent of the entire state's daily production.

"No other state, in spite of its so-called conservation laws, can approach this unitized production in percentage of oil produced. Only Texas, with 2½ times our total production, can equal it in actual barrels per day.

"In spite of the learned technical discussion advanced by the sponsors of this measure, I believe any honest and experienced engineer will agree that we still lack more than a rudimentary knowledge of what goes on in a reservoir and what constitutes good and efficient operation.

"There is the keenest competition among the companies through research, field experimentation, and actual practice of ways to increase both current and ultimate production.

"Much of this would be difficult or impossible were we to turn the control of such experimentation over to a politically appointed three-man commission which would follow the traditional commission type of administration, requiring long-winded hearings and time-consuming studies before permitting the present free-wheeling type of investigation that is presently carried on."

NEW METHOD advanced by Park Jones, Houston consulting engineer, above, is designed to take part of the guesswork out of reserve estimates on new oil and gas wells.

Wildcatter Gets Help

If he's lucky enough to strike oil, new reservoir-limit test tells him how much oil or gas is connected to well

HOUSTON.—Not many wildcats find production. When one does, there's always the question of just how much oil or gas has been found. Is there enough to make an offset well worthwhile? Is the reservoir big enough to justify buying nearby leases?

Heretofore, methods to answer these questions have been none too reliable. As a result, operators spend a lot of money drilling offset wells to prove each new reservoir. But, the money is wasted when, oftentimes, the reservoir is only pocket size and offsets are dry.

A Houston consulting engineer, Park Jones, has now advanced a method that appears to take some of the guesswork out of reserve estimates on new wells.

The "reservoir-limit test" as Jones calls it, uses flowing bottom-hole pressures to find the amount of oil or gas actually connected to the well. Jones derives the method from the fluid-flow equations of Hurst and van Everdingen and bases it on the conditions for steady-state flow.

The test is quick, simple, and cheap. It has been field tried in several areas and indications are that it is reliable.

Jones does not claim that the reservoir-limit test will show a well's recoverable reserves. But, he does claim that the test will usually give a good estimate of the oil or gas in place and actually connected with the well at the time of the test. Of course, the test cannot show oil or gas not connected to the well because of plugged perforations, permeability blocks, etc. It won't work in dead-oil reservoirs, but it can succeed in spite of nearby faults, oil-water contacts, or gas-oil contacts.

Like a sound wave . . . Jones' method is somewhat like measuring the size of a room by clocking the time it takes for a sound to bounce off the walls and echo back.

What the reservoir-limit test measures is the time required for the well to settle from unsteady-state flow to steady-state after it is opened to flow at a constant rate. From this measured time and from other routine information about the reservoir rocks and fluids, Jones figures the oil or gas connected to the well.

The test itself is essentially the same as any other flowing bottom-hole pressure survey. The pressure bomb is run into the producing interval while it is shut in to get the static pressure. Then the well is opened up on an adjustable choke so that flow rates can be kept constant. Length of the flowing test depends on the reservoir itself.

If it is a poor one, the well will reach steady-state flow fairly soon. The test likely will end at 24 hours. If the reservoir is a good one, the well may be a long time reaching steady state. The test may go on an additional 24 or 48 hours. However, it may be that the well, although it has not reached steady-state, will show enough reserves at the end of the first 24 hours to make further testing superfluous.

Mostly PVT data . . . Besides the information from the well test itself, the reservoir-limit calculations call mostly for basic PVT data that any laboratory can supply from a sample of the well fluid.

That information includes: volume factor, viscosity, compressibility, and saturation pressure of the reservoir oil. It also includes the volume factor, compressibility, compressibility factor, viscosity, and dew-point pressure of the reservoir gas. Other factors such as porosity, permeability, and interstitial water can be found from cores, sidewall samples, or well logs.

Graph is key . . . The real key to the reservoir-limit test is plotting values of a "Y" factor against time on log-log paper.

This "Y," as Jones defines it, is the psi. dry per day per reservoir barrel flow rate. As long as the well is on unsteady-state flow, the plot of "Y" will ordinarily fall off at about a 45° angle. When flow becomes steady-state, "Y" becomes constant.

With "Y" established, finding the connected oil or gas is simply a matter of plugging "Y" into the appropriate formula.

If the well was still on unsteady-state flow when the test ended, the result will show only the minimum amount of hydrocarbons. This is because, in unsteady-state, the well is drawing from only a part of the entire reservoir. And the calculations will show only that part of the reservoir that has been affected. If the well has gone on steady-state flow, the calculations will show total connected oil or gas.

Alabama Changes Spacing

MONTGOMERY.—Alabama's state legislature last week passed a new law permitting 160-acre spacing for wells deeper than 9,990 ft. if they are located in new fields.

However, the measure does not apply to Citronelle, one of the most important discoveries of 1955, where oil is being recovered at close to 12,000 ft.

It specifically exempts all present fields and areas within 5 miles of current production. Neither does the measure affect wells shallower than 9,990 ft. These will continue on 40-acre spacing.

Suit Snags Plant

Phillips warns rail fuss may thwart big plant deal

HOUSTON.—A dispute over extension of rail service threatens to hold up development of a multimillion-dollar petrochemical center proposed by Phillips Petroleum Co.

Phillips planned to extend the port area belt railroad a mile to the east to serve a $25,000,000 plant to be erected by Celanese Corp. The plant, which would manufacture a new polyolefin resin, would occupy a portion of the 950-acre site recently acquired by Phillips for industrial development by other companies (*The Oil and Gas Journal, April 2, page 74*).

Southern Pacific Lines objected to extension of the belt line. The company through an affiliate, Texas & New Orleans Railroad Co., operates a line less than a mile east of the industrial site.

Southern Pacific filed suit in federal district court seeking an injunction against extension of the belt line. The case has been set for hearing here April 16 before Federal District Judge Allen B. Hannay.

A Phillips official warned that Celanese may construct its plant elsewhere if rail facilities are not made available to the industrial site.

The belt line is owned by the Navigation District and is operated by Port Terminal Railroad Association.

New Firm Goes Offshore

TULSA.—Reading & Bates Offshore Drilling Co., Tulsa, has contracted for construction and equipment of two drilling tenders and will start operations in Gulf waters late in July.

J. W. (Jack) Bates, Jr., president of the newly organized firm, said the tenders will cost from $2¼ to $2½ million each. Levingston Ship Building Co., Orange, Tex., is building the tenders. National Supply Co. will equip them.

The first tender will be delivered and equipped by July 15 and the second by October 15. Both are under contract to the C.A.T.C. group (Continental, Atlantic Refining, Tide Water and Cities Service) for drilling in Gulf waters.

Bates also is president of Reading & Bates, Inc., a domestic drilling firm, and vice president of Reading & Bates Drilling Co., Ltd., of Canada. C. E. Thornton, Calgary, president of the Canadian affiliate, is vice president of the offshore company. J. W. Bates, Sr., Tulsa, is secretary and treasurer of all three firms.

Seeligson Field to Be Unitized

DALLAS.—Major operators in the huge, multizone Seeligson field of South Texas last week signed a unitization agreement covering 29 oil and gas reservoirs.

Planned pressure-maintenance operations, including both water and gas injection, are expected to increase ultimate oil recovery by 30 per cent.

The unit will be placed before the Texas Railroad Commission for approval when royalty and working-interest owners on 85 per cent of the surface acreage are signed up. More than 6 years of study went into developing the complex unit.

Unit details . . . The unit will embrace 15,000 acres of the field, discovered in 1937 by Magnolia Petroleum Co.

More than 700 wells have been drilled on the tracts being unitized. The zones involved are between 4,500 and 6,100 ft. in the Vicksburg. The field allowable is approximately 42,800 bbl. per producing day. Of the 806 oil wells which have allowables, 666 are in the proposed unit area in 21 different zones. The other eight zones produce only gas.

Sixty-three separate reservoirs have been discovered in the field.

Sun Oil Co., largest interest holder in Seeligson, will be unit operator. Magnolia Petroleum Co. will serve as plant operator.

The project calls for construction of a combined processing and cycling plant, which will be capable of handling 230,000,000 cu. ft. daily. Some 150,000,000 cu. ft. will be reinjected for pressure maintenance and 80,000,000 cu. ft. will be sold.

Large volumes of water also will be injected, but details were not released in the first announcement of the unit.

Field history . . . Seeligson field, located in Jim Wells and Kleberg counties about 150 miles south of San Antonio, had produced 143,375,000 bbl. of oil up to January 1 of this year.

Production last year amounted to 10,060,000 bbl. Estimated recoverable reserves for the entire field under primary recovery have been set at 256,625,000 bbl.

Participating operators, besides Magnolia and Sun, are Sunray Mid-Continent Oil Co., Shell Oil Co., Sinclair Oil Corp., Texas-Gulf Producing Co., Richardson-McCarrick interests, Richardson Oil Co., Ramsey interests, Renwar, The Texas Co., and Republic Natural Gas Co.

Industry BRIEFS

NEWCASTLE, Wyo.—Voss Oil Co. has purchased oil and uranium properties of Rosebud Oils, Inc., in Wyoming, South Dakota, and New Mexico.

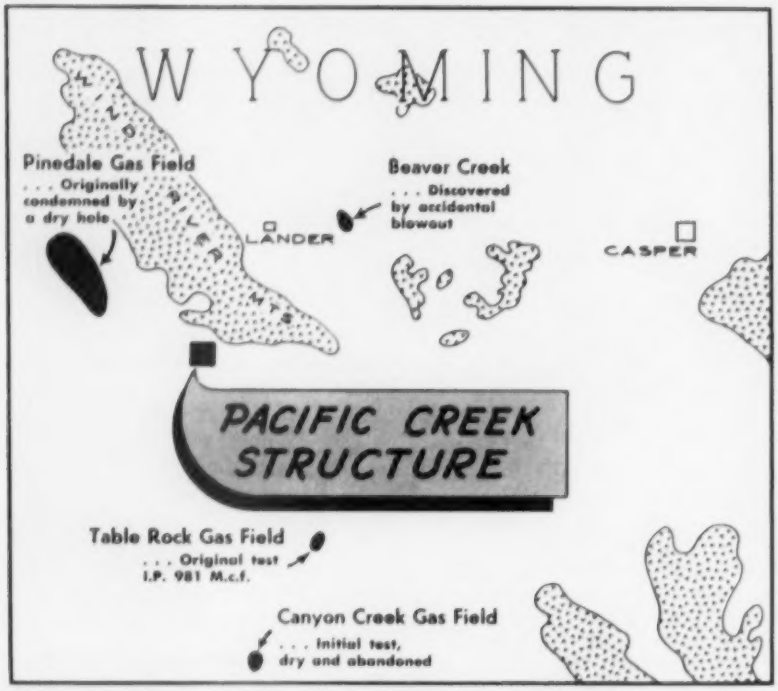
The Rosebud properties include 4,575 acres of oil leases and 25 per cent interest in 212 uranium claims assigned to General Minerals Corp. of Dallas. Voss issued 900,000 shares of treasury stock to acquire Rosebud's assets.

HUNTINGTON BEACH, Calif.— Offshore pipe-laying operations have begun on the new $1,000,000 marine loading terminal being built by Wilshire Oil Co. at Huntington Beach. The project includes a 24-in. line running 7,000 ft. seaward with an additional 5,000 ft. of line running from the shoreline to a tank farm now under construction onshore. The line will be capable of unloading tankers at the rate of 15,000 bbl. an hour. It is slated to go into operations May 15.

WASHINGTON.—Pennsylvania Gas Co. has asked Federal Power Commission authority to build two natural-gas pipelines totaling 38 miles in Pennsylvania and New York. The projects include 23 miles of 10-in. in Erie County, Pennsylvania, and 15 miles of 8-in. in Warren County, Pennsylvania, and Chautauqua County, New York. The expansion will cost about $930,000.

WASHINGTON.—Atlantic Seaboard Corp. of Charleston, W. Va., will build 86 miles of natural-gas pipeline in West Virginia and Virginia at a cost of $8,521,000. The Federal Power Commission approved 31 miles of line paralleling Atlantic Seaboard's existing 26-in. pipeline in the two states. A 55-mile line between compressor stations in Hardy County, West Virginia, and Greene County, Virginia, will link the company's 26 and 20-in. pipelines. The projects will add 70,600,000 cu. ft. daily to Atlantic Seaboard's capacity.

CASPER, Wyo.—Little Star Uranium Co. of Casper has absorbed Twin Arrow Petroleum Corp. and acquired its assets of $899,000 in an exchange of stock approved by shareholders of both firms. Twin Arrow properties included monthly production of 1,750 bbl. of crude oil in Wyoming and Colorado.


WYOMING
Pinedale Gas Field
. . . Originally condemned by a dry hole
Beaver Creek
. . . Discovered by accidental blowout
LANDER
CASPER
PACIFIC CREEK STRUCTURE
Table Rock Gas Field
. . . Original test I.P. 981 M.c.f.
Canyon Creek Gas Field
. . . Initial test, dry and abandoned

CRETACEOUS AND TERTIARY PRODUCTION in several Wyoming fields has been found in spite of discouraging initial tests. Better mud programs are responsible. They're behind plans for a . . .

New Test of Pacific Creek

CASPER.—Wyoming's Pacific Creek structure, once the site of the world's deepest hole, is going to be drilled again.

The big anticline has attracted little attention since it was "condemned" by a dry hole 7 years ago.

But new drilling techniques have made some geologists think promising formations may have been passed up as noncommercial when the original test was drilled.

Some of these are with The California Co., which has acquired a three-fourths interest in a 23,000-acre block surrounding Superior Oil Co.'s 1 Pacific Creek Unit. This wildcat, which set a drilling-depth record which stood for nearly 4½ years, was abandoned as a duster on July 1, 1949, at a total depth of 20,521 ft.

Calco has agreed to start a 13,000-ft. Mesa Verde test on the Pacific Creek structure by October 1.

Why a second time? . . . Superior's test at Pacific Creek logged several potential gas sands between 11,000 and 19,765 ft. It even flowed oil from some point within this depth range, according to reports. But tests indicated little hope of commercial production.

It is now known that many Tertiary and Cretaceous sands in the Rocky Mountains contain large amounts of clay, usually termed bentonitic. On contact with water, these clays swell. The swelling seriously reduces the porosity and permeability.

Experience in drilling these sands in recent years has shown that use of a high-water-loss mud can reduce drastically a sand's productivity, or even plug the sand. So operators have switched to use of an oil-base mud, or to drilling in with gas or air, or to use of a low-water-loss mud.

Figuring that the potential sands in Superior's costly wildcat may have been plugged by such swelling, Calco will drill the Mesa Verde with an oil-base mud.

Support for theory . . . That promising pay sands could have been water-blocked is indicated by developments in several other areas in Wyoming *(See map).*

In some instances producers have been completed in supposedly condemned sands simply by altering the drilling-in procedure.

A case in point is Canyon Creek gas field. The original hole was finally plugged after making only 900 M.c.f. of gas. The well was drilled with a high-water-loss mud. A south offset, drilled with gas, was completed for an initial potential of more than 10,000 M.c.f. daily.

Table Rock gas field has a similar history. The original test had an I.P. of 981 M.c.f. A later test, drilled with low-water-loss mud, registered an I.P. of 8,980 M.c.f.

Pinedale field, originally written off by a dry hole, now has Tertiary gas production from wells drilled with gas. In Beaver Creek Mesa Verde oil and gas sands were discovered by an accidental blowout. These zones had been drilled through for 10 to 15 years in seeking deeper horizons.

If Calco's plugging supposition is correct, the Pacific Creek structure could develop into a gas reserve of substantial proportions.

It is generally considered to be one of the largest seismic prospects mapped to date in the Green River basin. Before spudding in its deep wildcat, Superior did extensive shooting, then leased a block of 51,000 acres.

Small Refiners Get Help

WASHINGTON.—A program to channel more government oil contracts to the smaller suppliers will be put into effect this summer by the Armed Services Petroleum Purchasing Agency.

A fixed share of the military's needs for jet fuel and packaged products for delivery between October 1 and the following March 31 will be set aside for small business when invitations to bid are sent out next August.

The amounts to be set aside are yet to be figured out.

To qualify as small business, bidders must have less than 500 employees. Suppliers not offering their own product also must certify an intention to obtain it from a refinery qualifying as "small."

Beach Test Finds Oil

LOS ANGELES.—The first exploratory well slant-drilled offshore from Redondo Beach was completed flowing 172 bbl. of 26°-gravity crude daily. Production was from the interval 2,850-3,098 ft.

The wildcat was a joint venture of Signal Oil & Gas Co. (operator), Reserve Oil & Gas Co., and Artnell Oil & Gas Co.

Under terms of their contract with the city, a maximum of five other tests can be directionally drilled from the beachfront site. Additional development of the lease, which extends 4,000 ft. along the shoreline and about 3 miles seaward, would be carried on from offshore drill sites.

Rangely Law Wanted

Colorado commission to seek revamped conservation act, more authority as answer to reinjection-issue setback

DENVER.—The Colorado Oil and Gas Conservation Commission will ask the 1957 legislature next January to strengthen the existing Oil and Gas Conservation Act.

Proposed changes are being drafted by a committee named by Warwick M. Downing, commission chairman.

Downing said the present conservation act must be revamped to offset a May 1955 state Supreme Court decision which voided a commission-ordered gas reinjection program in Rangely field, largest in Colorado, on grounds the agency exceeded its authority.

The commission feels the act should define waste, especially the waste of gas, so that flaring may be stopped. It also wants the power to require operators to reinject gas, to carry on cycling operations, and to develop secondary-recovery methods.

Forced unitization . . . Arthur Jersin, recently appointed commission director, would like to see the legislature grant the commission authority to require unitization of any field as an effective weapon against waste.

"Admittedly," he said, "forced unitization would encroach on the correlative rights of operators and others, but it also would cut in half the flaring of gas which now is running about 11 per cent of all gas produced in the state.

"In Rangely field, for example, we could greatly prolong the estimated 40-year life of the area with unitization and secondary-recovery programs."

Although Rangely operators are voluntarily reinjecting all the gas their facilities can handle, Jersin said, 20,000,000 cu. ft. daily is still being flared. The Weber reservoir now averages about 65,000 bbl. of oil and 115,000,000 cu. ft. of gas daily.

Restrictions withdrawn . . . The commission withdrew all restrictions on production and flaring in the field following the adverse Supreme Court ruling last year.

"Actions in Rangely now are under strict observation by the commission," according to the director. However, he said, any restrictive order issued by the agency to correct "an unreasonable condition" there probably would be attacked in the courts.

The answer lies in clearly defined legislation.

Colorado's Oil and Gas Conservation Act, patterned after the Inter-State Oil Compact Commission's model conservation law, was enacted by the legislature in 1951.

The 1955 general assembly amended the 1951 statute, the commission said, but failed to clarify some of its provisions or to provide mandatory injection of excess gas.

Otherwise, the commission director said, Colorado has "a pretty good conservation law." He added:

Powerful weapon left . . . "We've got one powerful weapon which we have not yet been required to use. Under a rule adopted by the 1955 legislature, if a producer violates a regulation, the commission can impose a fine of $1,000 for each action of violation and for each day of violation."

Members of the Oil and Gas Conservation Commission serve without pay. Jersin is assisted by a deputy director and two petroleum engineers.

Drilling-Barge Contract Let

NEW ORLEANS.—Louisiana Offshore Drilling Co. has let contract for construction of a submersible drilling barge to operate in 67 ft. of water in the open gulf.

The vessel will be built by Ingalls Shipbuilding Co. at Pascagoula, Miss. Costing an estimated $3,000,000 fully equipped, the unit is expected to be ready for operations next spring.

It will be equipped with a special Lee C. Moore derrick designed so that three wells may be drilled without moving the barge. Having a lift rating of 1,000,000 lb., the derrick is designed for drilling to 20,000 ft. Mud pumps, draw works, and rotary will be driven by electric motors.

The barge was designed by Friede & Goldman, New Orleans. It will be 180 ft. long and 151 ft. wide.

Nebraska Oil Men Organize

LINCOLN, Neb.—The Nebraska oil and gas industry has organized its forces into a state association.

The organization, with Kenneth D. Monroe as executive manager, is expected to establish headquarters here so as to be near the center of state government.

Efforts to form the association had been under way since last August. Spearheading formation of the group was a seven-member committee composed of Fred Johnson, Harrisburg; Glenn Wallace, Hastings; Ray Smith, Chappell; S. E. Torgeson, Kimball; J. H. McNish, J. W. Gee and Paul L. Martin, all of Sidney; and W. F. Rogers, Scottsbluff.

All are independents except Laughlin of Stanolind Oil & Gas Co. and Gee of Ohio Oil Co.

Production Meet Set

Columbus to host A.P.I.'s eastern arm April 25-27

COLUMBUS, Ohio.—Sidney Swensrud, chairman of Gulf Oil Corp., will address the general session at the annual spring meeting of the Eastern district of the American Petroleum Institute's Division of Production here April 26.

The meeting, to continue through April 27, will be at the Deshler Hilton Hotel. First committee meetings will begin at 9 a.m. April 25. Carl J. Hauck, Ohio Fuel Gas Co., is chairman of general arrangements. Jack Cashell, of Preston Oil Co., Columbus, is Eastern Production Division chairman.

Speakers for the general and group sessions include:

Thursday, April 26

10 a.m. (general session)—Welcoming address, John W. Brown, lieutenant governor of Ohio; "Challenge of Drilling Costs," A. W. Thompson, A.P.I. Production vice president and head of A. W. Thompson, Inc., Houston; address by Swensrud.

1:45 p.m. (group session)—"Increased Primary Oil Production by the Wise Use of Surface-Active Agents," Wayne F. Wower, Halliburton Oil Well Cementing Co., and Arthur Stegelman, Jr., S&D Engineering Service, Evansville, Ind.; "Results of Test of High Resolution Seismic System in Medina County, Ohio," Robert J. Graebner, Geophysical Service, Inc., Dallas; "Water-Flood Efficiency Based on Field Data," Dr. Ralph Nielson and Dr. C. Drew Stahl, Pennsylvania State University.

Friday, April 27

9:30 a.m. (group session)—"Unique Tools and Methods Used in Conditioning Gas Wells," John A. Comet, United Natural Gas Co., Oil City, Pa.; "Gravity Surveys for the Appalachian Area," Richard A. Pohly, Pohly Exploration Co., Tulsa; "Uranium Exploration Methods for the Petroleum Industry," Jack Kratchman, geologist, U. S. Atomic Energy Commission; "Testing Greases and Oils for Year-Round Drilling Operations," William Humes, Kendall Refining Co., Bradford, Pa.

2 p.m. (group session)—"Fundamentals of Rock Drilling," Ralph Simon, D. E. Cooper, and M. L. Stoneman, Battelle Memorial Institute, Columbus; "Water-Flood Development in Louden Pool, Illinois," Ray E. Ashley, Jr., Carter Oil Co., Mattoon, Ill.

New Mud Mix Pays Off

Pure discovers water-in-oil emulsion results in greater production without fracturing and in lower well costs

WICHITA, Kans.—Greater production from new wells has been achieved in Kansas at lower drilling and completion costs by using a water-in-oil emusion drilling mud.

Pure Oil Co. tested the so-called inverted emulsion mud in a 13-well program in the Harper Ranch pool of Clark County. Five wells were drilled with conventional muds, eight wells with inverted emulsion mud. Production was from the Morrow sand.

Charles Hancock of Pure, in a report before the Mid-Continent district meeting of the A.P.I. Division of Production here, said the results were:

. . . Greater production—wells drilled with the new emulsion produced without stimulation. The rate was five times greater than from wells drilled with conventional water-base muds which had to be fractured.

. . . Lower costs—drilling and completion costs were reduced $1,900 per well with inverted emulsion mud. Savings principally were by eliminating need for fracture treatment.

Hancock emphasized the wells were development wells. He explained that actual savings depended on recovery of the inverted emulsion mud and its reuse in subsequent wells. However, because of stepped-up production, cost of the mud should not be the primary consideration, he said. The exception is where danger of losing most of the circulation system is great.

The conditions . . . Pure used a starch-treated, water-base mud prior to its work with inverted emulsion muds.

This is necessary rather than conventional chemical mud because wells penetrate red beds, salt, and anhydrite stringers. Only two casing strings are set, the surface and a lost circulation string. Wells are only about 5,500 ft. deep. But drilling is made difficult by severe lost circulation when mud weight increases above 9.2 and 9.3 lb. per gallon. Solids accumulation makes it difficult to hold water-base muds to this weight.

Costs of the starch run up to about $6,000 to $8,000 per well. Inverted emulsion muds costs this much initially because their makeup cost is about $8 to $9 per barrel. But their weight can be held below 8.6 lb. per gallon. This means a saving on circulation losses. Salvage of mud reduces the cost still further.

Drilling times . . . For the five wells drilled with starch muds, average drilling time from under the surface pipe to coring point was 19¾ days with 20¼ bits of 7⅞-in.

Inverted-emulsion mud drilling on eight wells averaged 26 days and 28 bits. But when initial difficulties were solved, the last three wells took only 16⅔ days and 19⅓ bits.

The payoff . . . The significant effects of the emulsion muds showed up in production of the wells.

All but one well drilled with starch mud failed to flow naturally. On one of the wells, all mud was swabbed out, the well was perforated and not even a blow of gas resulted. All the wells then were fractured and completed. Potential averaged 441 bbl. per day.

The wells drilled with inverted emulsion mud flowed naturally. Average state potential was 2,091 bbl. daily and the lowest potential was 1,426 bbl.

Also the wells drilled with inverted emulsion mud proved drill-stem tests mean something. This was not true for wells drilled with water-base muds. A dry drill-stem test on them meant nothing. Fracturing may bring in a good well. But three dry holes drilled with inverted emulsion muds showed that a dry drill-stem test is a true indication of the well's productivity. When these wells were fractured after such tests, they didn't even return the fracturing fluid.

Mud formula . . . Much trial and error was used to get the best mixture for the emulsion mud.

First the mud was mixed with about 60 per cent by volume diesel oil. Some salt was added to the water phase to stabilize the emulsion produced by the additive. But this type of oil apparently allowed caving of the red beds. This usually made running into the hole difficult after a trip.

Fracturing oil then was tried. Its high viscosity was counted on to prevent caving. But its fluorescence was very objectionable to company geologists, and other oils were sought.

Solution came with a light lubricating oil. It had high viscosity to prevent caving and also a limited fluorescence. Best muds with this oil ran about 88 to 90 per cent oil. The oil cost 11 cents per gallon.

After this mixture was used, caving trouble ceased and drilling rates increased. Experience also showed the inverted emulsion muds were very stable during drilling. The best emulsions resulted when saturated salt water is used. Fresh water should not be used because the emulsion might revert to an oil-in-water type.

Other advantages for the emulsion mud:

. . . It has excellent resistance to salt, anhydrite, and cement contamination.

. . . Viscosity is about 50 to 65 seconds with fluid loss zero.

. . . Salvage of muds was about 95 per cent. However, since the emulsion is not stable after prolonged time, the muds were not left in the hole after completion. A special mud pack was used.

Some troubles . . . Difficulties which occurred with the emulsion mud were

FOUR SERVICE AWARDS were presented at the A.P.I.'s Division of Production meeting in Wichita. A. W. Thompson, center, of A. W. Thompson, Inc., Houston, and A.P.I. vice president for production, presented the awards. Award winners were, left to right, John E. Eckel, Carter Oil Co., Tulsa; Howard G. Texter, Spang-Chalfant Division of National Supply Co., Tulsa; Thompson; George Berlin, Skelly Oil Co., Velma, Okla.; and Clayton Husted, of Clayton Husted, Contractors, Pampa, Tex.

due to buildup of fine formation solids in the mud.

This increased mud weight and stepped up the chances of lost circulation. Experiments showed this could be overcome by finer screening of the mud and keeping a high mud level in the pits to increase settling. Final screen size used on the vibrating shaker was 20 mesh. This necessitated a larger shaker area to prevent mud overflowing the screen.

Pure's work with the new mud mixture shows it will produce better wells at a saving. But Hancock said it is not recommended for all cases. If circulation losses cannot be controlled by reduction of mud weight, such as in cavernous zones, the emulsion mud would prove too expensive. The high cost of losing such expensive mud might overcome its many advantages.

Line to Be Boosted

Expansion set for biggest West Texas-Gulf crude line

HOUSTON.—Capacity of one of the major crude-oil lines between West Texas and the Gulf Coast will be increased more than 15 per cent within a few months.

West Texas Gulf Pipe Line Co. will add new pumps at three existing stations to boost capacity of the system from the present 381,000 bbl. to 440,000 bbl. daily. J. H. Russell, president, said the new facilities should be in operation by the end of the year.

The company thus becomes the third in recent months to map plans for possible expansion of crude lines moving Permian basin crude to refining centers. Rancho Pipe Line System and Magnolia Pipe Line Co. also are expected to increase capacities of their lines from that region *(The Oil and Gas Journal, March 26, page 68)*.

The largest crude system originating in Permian basin, West Texas Gulf's line, was completed in 1953. The line is 26 in. in diameter from Colorado City to Wortham, Tex. There the system splits into a 24-in. line to the Lucas, Tex., area and a 20-in. line to Longview, Tex.

West Texas Gulf will add two new pumps at each of three stations—Abilene, Blum, and Trinity. Pumps at Abilene and Blum will be of 2,000 hp. each. Those at the Trinity Station will be rated at 1,500 hp. each.

Gulf Oil Corp., which operates one of the nation's largest refineries at Port Arthur, Tex., owns about 57 per cent of West Texas Gulf. Other companies with an interest are Cities Service Oil Co., Pure Oil Co., Sun Pipe Line Co., and Standard Oil Co. (Ohio).

watching WASHINGTON

. . . with Bertram F. Linz

Patent holdings to come under fire again . . .

A NEW effort to break up large patent holdings in the oil and other industries will be launched in Congress shortly.

A bill now being written would require holders of patents either to use them or permit others to do so. Its aim is to prevent the suppression of patents.

A Senate committee recently wound up another of many studies of the patent situation that have been made over the years. As usual, there was a complaint that large companies have bought and shelved valuable patents because they were satisfied with their products or production methods and didn't want to make expensive changes.

Past attempts to enact a patent-freedom law failed. The Justice Department, however, has used the antitrust laws effectively in a few instances, notably in the telephone, automobile, and electrical industries.

Good-faith price cuts should survive assault . . .

EFFORTS of congressional champions of small business to weaken the good-faith defense in Robinson-Patman price-cutting cases is fast losing steam.

The House judiciary committee will hold hearings on the subject this month. But the Justice and Commerce departments and Federal Trade Commission already have expressed their opposition to a change in the law which recognizes the legality of price cuts to individual customers to meet competition. Their stand will lessen its chances of passage.

The bill would make the good-faith provision meaningless, the Justice Department said. The same result could be as easily obtained by repeal of the provision itself. The department does not recommend that.

"While we recognize the competitive problems which arise when the purchaser obtains advantages denied to other purchasers, we do not believe the solution of the problem lies in denying sellers the opportunity to make sales in good-faith competition with other sellers," the committee was told.

The FTC takes the position that no need for a change in the law has been shown. Future cases, it said, may indicate that the provision as now worded would hamper enforcement. But no basis for such a belief has been found so far.

Presenting the viewpoint of business, the Commerce Department said the change would place a great burden upon sellers. Before cutting prices to meet competition, they would have to determine whether it would tend to lessen competition substantially. That is impossible to decide off-hand.

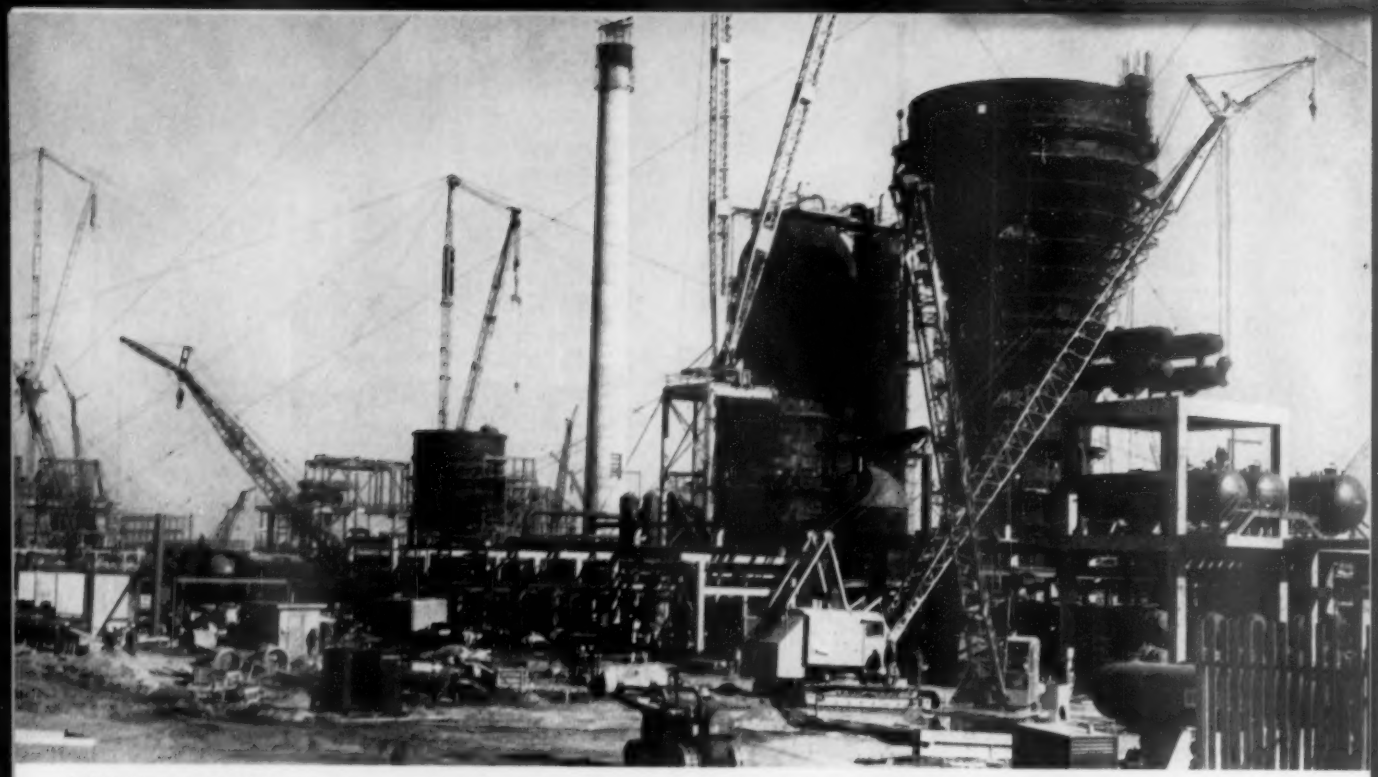
Committee hearing to put fresh heat on WOC's . . .

LAST year's probe of industry experts serving the Government without compensation is about to break out into the open again.

A House committee which has been laying the groundwork over a period of months will open public hearings in the next couple of weeks. It recently was given $500,000 for its inquiry into alleged conflict of interest and favoritism among "WOC's."

The investigation will cover industry men who served in the Petroleum Administration for Defense, Interior's Oil and Gas Division, and other federal agencies. But the committee has indicated it will go much further. It plans also to study business advisory groups such as the National Petroleum Council which have a close relationship with the Government. And it may go into the activities of industrial consultants to the military and other departments who are paid on a daily fee basis.

There is still a feeling in Congress that industry has been given too much influence in government. That is inescapable in wartime, it is said. But in peacetime the reins should be in the hands of government officials who have no ties with the business world.



EXPENSIVE OCTANES are taxing refiners' pocketbooks and technology. Tide Water is spending $230 million building its new Delaware City refinery, above, and a similar one at Avon, Calif. The Delaware City plant will have the world's largest crude unit, 130,000 bbl. daily; the largest catalytic cracker, a 102,000-bbl. daily Orthoflow unit; and the largest Fluid coker, 45,000 bbl. daily. It shows...

There's No End to Refiners' Headaches

Fight for higher octanes may be heading into technical troubles as old processes suddenly are put to new uses

Plant operators also concerned over crude price hike; if oil should be raised, gasoline prices must also go up

Larry Resen

HOUSTON. — What are the biggest problems facing refiners today? What are the answers for them?

Refiners are talking the most about octanes. But a survey in plants throughout the country shows they also are voicing concern over a possible crude-price increase. The undercurrent is so strong that concern over prices contends with octanes for top place.

When the refiners are not occupied with octanes and prices, their discussions turn to volatility, isomerization, gasoline stocks, and engine designs—all of which are posing special problems these days.

Price squeeze . . . Any increase in crude prices would catch most refiners in a bind.

They don't say an increase isn't justified. But the refiner is the oil industry's direct contact man with the public. Any crude-price rise now would mean an increase in gasoline prices—an unpopular step at best.

Some of the added crude price might be passed on by raising intermediate distillate prices, but gasoline would have to bear the brunt. Actually, refiners absorbed a great deal of the last crude-price increase, and today's narrow margins definitely eliminate that route again.

The talk of a crude-price increase also comes at a time when the gasoline market already is soft. The consumer, meanwhile, has seen his gasoline prices going up as state taxes have been elevated. And in the background is the specter of an additional 1-cent federal tax to support the prospective national highway construction program.

It all adds up to a ticklish spot for the refiner.

Those costly octanes . . . The industry-wide push for high-octane, high-quality gasoline also is putting a double strain on refiners.

There's no doubt the present octane race is straining the refiner's pocketbook a little bit more each day. It's also straining his technology.

On the cost side, the expense of adding octane formerly was measured in fractions of a cent per barrel. Now refiners measure it in several cents. Everyone knows that with each increase in octanes, costs skyrocket. And the problem has been aggravated by the reluctance of price leaders to pass along to the customer the extra costs involved in high-quality products.

This "policy" has put other refiners in a bind—both in prices and customer relations. Now, the average consumer tends to be suspicious of gasoline prices.

The trend toward higher-octane fuel has made the low-octane regular grades a drug on the market. Government offshore purchasing contracts haven't helped. For instance, in the Carribbean area, jet fuel is purchased from operators not burdened with domestic taxes. It's moved in foreign flagships and is sold without any duty being levied. Government purchases there back up low-octane fuels in the states. With these jet-fuel outlets closed, the refiner can't blend his excess low-octane gas-

oline into jet fuels and is faced with an expensive upgrading problem.

The Government also can take some of the dubious credit for the top-heavy inventory situation. Basically, the Government has promoted building of standby capacity for production of high-quality products—principally 130-145 grade avgas. Refiners who have built up this capacity have to use it, otherwise the depreciation eats them up. Hence, the equipment is kept on stream. The result is surplus stocks and then a price depression.

The most interesting development as a way out of the price squeeze has been Sun Oil Co.'s multigrade experiment in Florida.

The 5-cent differential Sun posts between the lowest and highest-grade fuels is sensible. And each customer will pay his share according to the quality he wants—and needs. It's complete turnabout for Sun, of course. And it'll be about as radical a move for the entire industry if it's adopted. Everyone's going to take a long look at Sun's results.

Technical headache . . . Even if the cost problem of high octanes is solved, most refiners agree the technical headache will remain.

Octanes have moved too far, too fast, and serious problems have resulted. Catalytic reforming has taken refiners a long way in upgrading naphthas to high-octane products. In 2 years, however, the saturation point will be reached. A nation-wide pool research octane number of 93 will not be enough to handle requirements down the line. It becomes quite costly to increase octane numbers by increasing reforming severity, and the refiner will have to take another long look.

The unorthodox will tend to become the commonplace. For instance, alkylation principally restricted to avgas manufacture in the past is coming more and more into the motor-fuel picture. With isobutane and fuel costs within reason, this process becomes more attractive for motor blends.

An old process is also being dusted off—isomerization. It's been used for specialty work heretofore, but isomerization of C_5, C_6, and even C_7 is in the picture, although possibly as a last resort following alkylation. This latter process, incidentally, is tending to displace polymerization in the blending picture as octanes rise.

Isomerization has been in the news before. And it has serious limitations—both economic and technical. A critical factor in its application, however, may be volatility, especially when converting normal pentane to the isomer. The isopentane product has a somewhat higher vapor pressure than n-pentane. Hence, the gain in octane numbers may be partially offset since less butane, with its cheap octane numbers, could then be blended. This situation will be less aggravated in hexane and heptane isomerization.

At any rate, volatility promises to become a bigger problem. This will probably make amylene alkylation more and more attractive. Alkylation is going to play a bigger role and amylene charge to an alky unit improves the volatility of the product. As a matter of fact, the refiner can actually blend more normal butane when taking this route.

Role of Detroit . . . Automobile manufacturers can help in the volatility problem. But reports indicate they are going in the other direction.

If anything, it sounds as if volatility will be more serious in coming engine designs. Low silhouettes, air conditioning, power equipment—all of these will contribute to making a car sensitive to vapor lock. Designers already have moved the fuel pump back a bit. It might be they'll have to develop a practical pressure system with the pump in the gasoline tank. Cooling the fuel lines is another possibility.

Fuel injection has a long road to follow, meanwhile. It is also subject to vapor lock under certain conditions. The designers should work on this problem and not try to get the refiners to make new fuels. They'd like a fuel with no front end and no heavy end—just the middle, and that's an expensive route.

When refiners get requests for specially compounded test fuels from engine designers, they'd do well to try to get the request modified to a fuel which can be commercially produced. An engine designed around a specialty fuel can lead to complications.

Being able to predict engine designs just 2 years away is becoming an increasing problem. All refiners are faced with what the engine requirements are to be. The auto manufacturers, meanwhile, come out with implications, but nothing definite.

A case in point is the lower silhouettes to come. The smaller wheels and step-down bodies will tend to increase the angle between the drive shaft and pinion gear. With greater torque and higher speeds to come, this could develop into a need for extreme-pressure lubricants. Making these E.P. lubricants in volume could throw the entire lubrication picture out of focus. Data and details on developments such as these ahead of time could aid the refiner in his planning.

Petrochemicals . . . More and more, the refiner has to turn to high-quality and high-cost products to enhance his profit picture.

With conventional products keeping him pinned down to a narrow profit margin, petrochemicals become more attractive. While some operators prefer to stay out of this industry, the high-octane race may actually force them to back in, if nothing else.

As higher octanes are obtained from plant processes, the light ends available also increase. Within limits, the refiner can dehydrogenate and isomerize as necessary to get alkylation unit feedstock, thereby upgrading his light ends. As more become available, he may then dehydrogenate and go to thermal processes to produce acetylene and ethylene. He can sell these, or take the next logical step and get into petrochemicals. Either way, he'll find himself in the petrochemical business. Even the small refiners can find this attractive.

Small refiners . . . Speaking of the small refiner, what's the outlook for him?

As usual, smaller operators have a rough road to travel. There was a big rash of shutdowns not too long ago, and recently one small plant shut down because of a jump in pipeline octane specifications. However, there are many vigorous and aggressive small refiners in business who plan to stay in business.

The competitive situation means they have to broaden their base. You'll find those with just reforming facilities adding cracking units and those with cat crackers adding reformers. The day of the "complete" refinery is at hand and the small refiner has to keep pace.

Other problems . . . All the refiner's headaches aren't big ones.

Distillate fuel oil additives can qualify as a minor problem. Cracked distillates are cheap, but have low quality and stability. Hydrogen treating is helping in this field, but to the small refiner, again, additives represent the simplest way to achieve this end. Some additives are now on the market, but new and improved ones will help.

A better comparison between octane numbers—road vs. motor vs. research—is needed. Too much confusion now exists between results.

Steel is in short supply and is dragging out some construction projects. Of course, this is a problem for the steel industry, but if it were more readily available, it would help. Alloys are especially critical.

Computer Tips Offered

Natural-gasoline meeting told of time, manpower savings from machine solution of design and operating problems

FORT WORTH. — Electronic computers have proven their worth in speeding design and operating calculations in natural-gasoline plants.

They're paying off in faster, more accurate results with less manpower. These savings show that the costly computers can earn their own way. But a company's work load must be high enough to keep them busy.

Authors of three papers reached these conclusions here last week at the annual meeting of the Natural Gasoline Association of America. Computer performance was discussed in a forum on process-calculation techniques by J. R. Cobb and R. L. McIntire, Phillips Petroleum Co., Bartlesville, Okla.; J. C. Schneider and R. G. Wright, Shell Oil Co., Midland, Tex.; and Dr. Elliott Organick, University of Houston.

Phillips uses a medium-sized unit of the magnetic-drum type in its mathematical engineering group, a division of the research and development department, Cobb and McIntire said. This machine can reach a step-by-step solution of a 50-tray fractionator in 2 hours.

A card-programed electronic computer would require 10 to 20 hours for the solution, and a man making a hand solution would never obtain the precision of the machine. Even a rough manual step-by-step calculation of the same problem requires 6 weeks to 3 months, they said.

How they help . . . Electronic computers save time and boost efficiency in several ways. Their use results in:

. . . Added precision. The machine can calculate problems that a man working with a slide rule could never solve because of low precision.

. . . Reserve help. Design and operating groups that are temporarily overloaded can transfer some of their work to the machine group.

. . . More speed. Increased production or quicker construction often results when the machine grinds out a precise answer in short order.

. . . Morale boost. The computer frees men from tedious, routine calculations and gives them more time to do creative work.

Absorber calculations . . . These calculations lend themselves particularly well to machine solution. The complications of intercoolers, widely varying vapor rates, and the absorbing effect of heavy components in the feed are easily handled.

The computer simply makes a series of passes down the column for different assumptions of the overhead composition until the calculated vapor to the feed tray equals the absorber feed.

In reboiled absorbers, the machine makes revisions in the product streams by comparing the vapor streams at the feed step, as calculated from both the overhead and bottoms product.

Each step is calculated by trial and error. A temperature on the tray is assumed, and a corresponding heat balance is made. This is continued until a temperature is found which will satisfy both heat and material balances.

The most common absorber problem is the determination of required oil rate on an existing unit, where number of plates and separation are fixed. This is handled on the computer by determining separation at several different oil rates and picking the best one from the results.

Shell work . . . Shell is using its Midland computer for a number of gasoline-plant calculations. These include prospective plant designs, checks of existing plants, and calculations of changes in operating conditions which vary with the season and composition of the field gas.

The Shell computer is a card-programed unit which is used by all Shell engineering groups in the Midland exploration and producing area. The machine is classified as a small pumper.

The programing is set up to handle each column or unit operation as a unit of calculation. An absorber calculation, for example, is set up so that only the input data need be changed for the machine to determine a different set of operating conditions.

Equilibrium flashes and other operations such as stripping, distillation, and rich-oil deethanizing are programed in the same manner. In this way the initial programing time is utilized time and again in the solution of many problems, Schneider and Wright said.

Lean-oil calculation . . . The first process-calculation problem set up for the computer required the determination of the economics of lean-oil circulation at a gasoline plant.

This plant was designed to recover 60 per cent of the propane from 90 million cubic feet per day of inlet gas, but the field is producing only 65 million cubic feet. The plant has two parallel sets of stills and fractionators, but one set can handle the gas now available. However, propane recovery is reduced when only half the plant is operating.

The problem required the weighing of increased fuel, operating, and maintenance cost against the increased revenue to be derived from operating the shutdown process area. Calculations had to cover a range of gas volumes, propane prices, and operating conditions throughout the year.

Programing this problem took 2 days. And a complete calculation cycle required about 5 hours, as compared with 3 to 5 days on a desk calculator.

PROCESS CALCULATION chairman and authors huddle before N.G.A.A. forum at Fort Worth. Left to right are: R. L. McIntire, Phillips Petroleum Co.; R. G. Wright, Shell Oil Co.; J. R. Cobb, Phillips Petroleum; M. F. Wirges, forum chairman, Cities Service Oil Co.; and Dr. Elliott I. Organick, University of Houston. McIntire, Cobb, and Wirges are located at Bartlesville and Wright is at Midland.

FPC Threatens Ban

Proposed rule would erase all automatic escalations

WASHINGTON. — Independent gas producers are in danger of losing their strongest weapon for keeping their prices abreast of the market.

A new rule planned by the Federal Power Commission would outlaw all but two types of escalation clauses in sales contracts after next July 1.

The only price-increase provisions acceptable to the FPC after that date would be those providing for specific increases at definite dates or to compensate the producer for increased taxes.

All types of automatic escalations would be banned under the rule. The four most generally used types were spelled out by the FPC in its announcement. These are:

... **The two-party favored-nation** clause which increases the producer's price if the buying pipeline pays a higher price to another producer in the same field or area.

... **The third-party favored-nation** clause which increases the price if a third party pays a higher price to any producer for gas from the same field or area, or offers to buy at a higher price.

... **Price redetermination** provisions setting prices on the basis of certain index figures—usually if the average of the 2 or 3 highest prices paid by pipelines in a given area exceed the contract price.

... **Spiral escalator clauses** under which the price is increased if the pipeline company's wholesale rates are raised.

The FPC has given interested persons until June 1 to submit their views and comments. It expects a flood of strong protests.

Roadways May Be Leased

HOUSTON.—Harris County hopes to cash in on some of the oil that presumably lies beneath its highways.

Commissioners Court requested County Attorney Burke Holman to prepare a study aimed at possible leasing of county rights of way through oil fields.

The right-of-way study will cover county roads near such fields as Pierce Junction, South Houston, Rosehill, Katy, and several others. The county realizes between $300 and $400 a month from its lone oil well, which is in South Houston field. The producer is on a plot of land in which the county retained mineral rights when the acreage was sold.

Lea Trend Boosted

Test points up importance of Devonian in New Mexico

HOBBS.—Northeastern Lea County's "Devonian Trend" got another boost last week.

The Ralph Lowe 1 Wallace, located 3 miles northeast of Gladiola-Devonian field, was completed at the rate of 2,640 bbl. of 46°-gravity oil a day. Production was through ¾-in. choke from pay at 11,990-12,046 ft. Flowing pressure was 260 psi. and gas-oil ratio was 300:1.

The daily potential was based on a 6-hour flow test following 500-gal. mud-acid and regular acid treatment on perforations. Sample top on the Devonian was 11,975 ft.

The Devonian is now the object of intense exploration work along the eastern border of Southeast New Mexico. Its recent and rapid growth is pointed up by production figures. It has accounted for only 5 per cent of the state's cumulative production, but 28 fields are producing about one-fourth of the current New Mexico output.

Geologists working the area say that Devonian structures apparently are on parallel ridges, with a north-south alignment. One such "ridge" has been indicated as running north-south through Bagley field and another the same direction through Denton field. The new strike north of Gladiola tends to support geologists' theories.

Highest Well Abandoned

CALGARY.—Canada's highest well has been abandoned as a junked hole after the crew failed in attempts to recover three 11½-in. drill collars and a 12¼-in. bit which became stuck at 1,325 ft.

The venture is the 3 Savanna Creek drilled atop Plateau Mountain in southwestern Alberta at an elevation of 8,134 ft., the highest surface on record for the oil industry in western Canada.

The well is 1¾ miles north of the Savanna Creek gas-condensate discovery. It is part of development work in the only pool inside the Canadian Rockies.

Fair Rule Assured

Texans told means will be found for ratable gas take

HOUSTON.—Ratable take of natural gas is becoming necessary and the Texas Railroad Commission is confident ways will be found to give each producer a chance to produce his fair share of the gas in a common reservoir.

John S. Cameron, Jr., senior gas engineer for the commission, gave that assurance last week in addressing the ninth oil-recovery conference held by the Texas Petroleum Research Committee at Texas A. & M. College.

Cameron stressed the great difference between prorating oil and natural gas. He said the most widely used proration approach is basing two-thirds of the allowable production on acreage held and one-third on number of wells.

"Probably the most important factor in any formula is acreage," he said. "The commission has been reluctant to adopt an allocation formula involving potential. That factor is subject to considerable abuse and is considered by many engineers as being at best inaccurate and questionable."

Cameron explained the commission never has issued allowables on the basis of reserves under a well. When a pipeline is contractually committed to produce according to reserves, it is frequently found that production is much different from the allowable assigned by the present system.

Two problems . . . Two major problems in gas proration are inaccurate nominations and capability tests, Cameron said.

The producer should nominate his actual demand and submit a true capability test—it's always to his advantage, the speaker stressed. The present system of proration is doing a good job insuring ratable take in many Texas fields but the system cannot work properly if some operators do not nominate and produce according to the rules.

Cameron declared state-wide gas proration does not appear feasible now because of widespread distances between fields and differing reservoir conditions in various parts of Texas. He said some plan may be worked out in the future when the demand for gas levels off.

Feed Stocks of Tomorrow

Petrochemistry must play second fiddle to octane race, taking raw materials the refiner doesn't need for fuels

DALLAS.—Soaring gasoline octanes are rapidly forcing big changes in the petrochemical-manufacturing picture by dictating which light hydrocarbons may be used as raw materials.

The petrochemical manufacturer in general sees two things:

. . . **Higher-octane materials** soon will be out of reach as feed stocks for petrochemical plants because of their value to the gasoline refiner.

. . . **The petrochem producer** making chemicals from high-octane materials must develop economical methods of using other hydrocarbons as raw materials.

This line of reasoning, according to J. A. Sherred, Monsanto Chemical Co., St. Louis, points the finger squarely at natural and straight-run gasolines and normal butane as likely future petrochemical raw-materials sources.

Sherred made these predictions during a symposium conducted at the petroleum division of the American Chemical Society meeting here.

Natural and straight-run gasolines, Sherred said, are no longer worth as much to the refiner as they once were in making finished gasoline. Natural and straight-run are losing their place as blending components and are now becoming gasoline raw materials.

Processes are already known for segregating the low octane-number normal paraffins, normal pentane and normal hexane. These are hard for the refiner to upgrade with available processes. Petrochem manufacturers can be expected to take advantage of these materials for feed.

Normal butane also may be a highly important chemical raw material. Production of this product in the field continues to climb. This supply is augmented, too, by an increasing volume of byproduct butane from catalytic operations at the refinery.

Mark these off . . . The petrochemical manufacturer, Sherred thinks, can mark off isobutane, toluene, xylenes, propylene, and butylenes as presently used raw materials for petrochemical manufacture which likely will not be available in the future.

Isobutane is a raw material for alkylate and is becoming more and more desirable for fuels refining.

So are propylene and butylenes. These olefins are essential raw materials for alkylate production. Indications that refiners will be able to spare less for chemical-making are already apparent. For example, new butadiene facilities are nearly all based on normal butane as feed.

Toluene and xylenes produced by cat reforming rate as some of the highest-octane products available to the refiner. Prices of these materials will continue to go up with octanes.

Dependence on refiner . . . The chemical-producing industry, though growing amazingly, is still small compared to the fuels industry.

The fuels industry is so big that there is little the petrochemical producer can do to change that industry to suit his needs.

He must either accept a position as a processor of fuel-industry byproducts whose availability at any given time is outside his control or pay a premium to buy away from the fuels industry. He chooses the former.

Thus, Sherred said, the petrochemical producer "lives in a raw-materials climate he can control as little as he can control the weather. If he cannot control it then he must try to forecast it."

Accurate forecasting of the future economics of processing a certain raw material is just as important as predicting the demand for the ultimate product.

This is vital, Sherred said, because the petrochemical producer must lay out huge sums for what is a relatively inflexible operation when compared to fuels refining. The chemical plant generally is not adaptable to switching from one basic raw material to another.

With a big capital investment and manufacturing inflexibility, the manufacturer can't afford to choose the wrong raw material.

Atomic energy put to work . . .

. . . Tracers Get Refining Job

DALLAS.—Radioactive tracers may be used in fluid catalytic cracking units to increase efficiency and cut costs of operation.

This is the conclusion reached by a group of Shell Development Co. scientists who presented their findings at the American Chemical Society meeting here last week.

These tracers help to locate regions of stagnant catalyst, short circuiting, and uniform mixing in the reactor and regenerator vessels, D. B. Todd reported. Once these zones are properly identified, catalyst holding times in the reactor and in the regenerator can be determined.

Holding time in the reactor affects the rate of coke lay-down during catalytic cracking, and holding time in the regenerator affects the rate of coke burn-off. When these relationships are known, operating conditions can be changed or equipment can be modified to give longer catalyst life and better conversion of gas oil to gasoline.

Shell scientists injected a few pounds of fresh catalyst, tagged with about one millicurie of gamma emitter, into the catalyst flow system. They followed this by rapid sampling at selected points in the reactor and regenerator.

Then they used the radioactivity levels of the samples to calculate catalyst retention-time patterns throughout the system.

Catalyst loss . . . The loss of fresh catalyst from the fluid catalytic cracking unit stack can be determined and then controlled by tracers, Todd said.

Operators use controlled withdrawal through the stack to maintain catalyst selectivity and activity. And they need to know what proportion of the removed catalyst is fresh material which has been added to the unit recently.

The makeup catalyst is tagged with radioactive tracer, and periodic samples of catalyst fines going to the stack are taken.

Two stack-loss tests indicated that intermittent injection of fresh catalyst over a 24-hour period is better than a single injection each day. In a test where the fresh catalyst was added over a 24-hour period, 12 per cent was lost during the introduction period.

In another test the loss of fresh catalyst from a plant inventory of coarser equilibrium catalyst was 22 per cent during the first day after a single injection, Todd said.

Gas mixing . . . Tracer studies show that mixing in the fluid bed of catalytic cracking units is incomplete, according to A. E. Handlos. He used helium gas to study the behavior of the gas phase in the regenerator of a catalytic unit.

Thus, the assumption of a well-mixed stage, usually made in calculations on the behavior of fluidized systems, should be used with reservation, he said.

The concentration of stack gas from

a unit is also affected by the degree of mixing in the gas phase, he said.

Catalyst study . . . It is now possible to determine the nature of cracking catalyst deactivation, W. G. Appleby said. This procedure will enable the operator to avoid operating conditions which are especially harmful to the catalyst.

Fresh catalyst is tagged with a radioactive tracer, and changes in properties are determined as the catalyst ages in use. In one test catalyst-surface area decreased about 75 per cent in the 24-hour period following addition. At the same time, about 60 per cent of the pore volume was lost.

Deactivation rate was much slower after the first 24 hours. The loss in surface area continued to be more rapid than the pore-volume loss, he said.

Tidelands Showdown

California 'marginal belt' test goes to Supreme Court

WASHINGTON.—The 18-year fight over the ownership of California's tidelands oil reached the Supreme Court last week.

Clarence I. Justheim and 39 other applicants for federal leases asked the court to find that the state's marginal belt is "public lands" and subject to leasing by the Interior Department under the Mineral Leasing Act.

The 40 petitioners filed 50 applications for leases with the department between April 1, 1938, and August 11, 1947. Their applications, and others involved in nine suits still pending in the District of Columbia Federal Court, were rejected by the department on the ground the act did not apply to submerged lands in the marginal sea.

The District of Columbia Court supported the department. Its decision was affirmed last January 5 by the Circuit Court of Appeals.

Telling the court that "a lot of money" is involved in the case, Justheim's petition said it should determine the rights of applications covering thousands of acres.

The petition said the lease rights are worth millions of dollars.

It contended that Congress recognized "the importance" of these rights in passing the 1953 bill returning tidelands to the states. That bill, the court was told, called for the protection of applications made under earlier laws.

The suit challenges the department's position that the leasing act doesn't apply to offshore lands. The wording of the act includes submerged lands in the marginal seas, it is contended.

Hanlon Award Goes to Vaughn

FORT WORTH.—The Hanlon Award, natural gasoline industry's highest honor and a ranking award of the petroleum industry, was presented last week to W. H. (Jack) Vaughn, the father of gas cycling.

Vaughn, manager of the gas utilization department of Tide Water Associated Oil Corp., Houston, was the twentieth person to receive the award, presented annually by the Natural Gasoline Association of America for outstanding service.

Presentation was made by N.G.A.A. President A. H. Weil, United Gas Pipe Line Co., Shreveport, at the association's thirty-fifth annual convention here. The citation read in part:

"We are recognizing the results of this man's studies of high-pressure, two-phase gas streams. The success of his first plant, the forerunner of many similar plants to come, proved that gas-condensate wells could be produced economically and thus the gas cycling industry was born."

Vaughn's experiments in the Cayuga field of central Texas led to his design and construction of the first cycling plant to obtain operating permission from the Texas Railroad Commission.

A native of Ozark, Mo., Vaughn has been associated with the Frisco Railroad, the old Gypsy Oil Co. and Gulf Oil Corp., where he was superintendent of natural gasoline operations.

W. H. VAUGHN

Vaughn resigned from Gulf in 1933 to conduct private research work, but joined Tide Water Associated 2 years later to supervise the firm's gas-condensate fields.

The Hanlon Award is conferred by E. I. Hanlon, board chairman of the National Bank of Tulsa and a pioneer in the natural-gasoline industry.

Processing BRIEFS

EDMONTON. — W. M. V. Ash, president of Shell Oil Co. of Canada, indicated here recently his company may build a refinery in Alberta.

During an inspection trip of marketing facilities in the province, he said his company is "studying the economics" of the refinery situation. But no definite plans had been made. No land has been bought and there is no indication whether the proposed refinery might be in the Edmonton or Calgary areas.

TULSA.—D-X Sunray Oil Co. will expand the technical services program at its West Tulsa refinery by doubling the size of the laboratories and hiring more chemists, engineers, and technicians. The experimental, analytical, and physical inspection laboratories will be expanded, increasing floor space to 20,200 sq. ft. Cost will be $500,000. The research and technical services division now employs 135 persons.

BALTIMORE. — Consolidated Sol-vents Corp. looks at petrochemicals as one of its more profitable areas of business and plans to spend $10,000,000 this year to expand the field. A methanol plant at Sterlington, La., will be expanded and facilities at Terre Haute, Ind., to process C.S.C.'s basic products into chemical derivatives will be boosted.

Commercial Solvents expects to be in full production on nitroparaffins later this year at its $5,000,000 plant at Sterlington. Later this year, Northwest Nitro-Chemicals, Ltd., will complete a major ammonia plant at Medicine Hat, Alberta, which was started last July.

PONCA CITY, Okla.—A catalytic reformer and auxiliary facility with a total capacity of 11,000 bbl. daily will be added at Continental Oil Co.'s refinery here. The expansion will cost approximately $3,000,000 and will start this summer. Completion is scheduled for mid-1957.

The installation is designed to improve gasoline quality to meet requirements of high-compression engines and to produce aromatics for use in Continental's petrochemical-manufacturing operations. Construction contract has been awarded M. W. Kellogg Co.

More State Control?

Big fight to define federal, state power may be coming

WASHINGTON.—Control of natural-gas regulation might be returned to state jurisdiction.

A Supreme Court decision that only the federal Government may prosecute sedition cases may touch off a major fight in Congress to return to the states some of the rights which they complain the Washington Government is nibbling away.

A bill to more clearly define the line between federal and state power has been pending since 1954. Supporters, mostly from the southern states, say that if the bill ever reaches the floor for vote it will be passed readily. But so far they have been unable to get the bill out of committee.

Passage of the bill would leave the state effective in any field in which Congress did not specifically claim paramount power for the federal Government. The overriding of state laws in the past has been by Supreme Court decisions rather than assertions by Congress.

If Congress should adopt a new policy of delineating the scope of its legislation it would leave the states free in such matters as natural-gas regulation, transportation, labor, and other fields in which the federal Government has gradually been extending its power.

Although it was the sedition ruling which brought new pressure for legislation, the bill now in Congress is very general in its terms.

It provides merely that no act of Congress shall be construed as superseding state law on the same matter unless it is so provided specifically. And no act of Congress would invalidate a state law which otherwise would be effective unless there is a direct and positive conflict between the two that cannot be reconciled.

The Supreme Court decision, which nullified a Pennsylvania law on sedition, also killed similar laws of 41 other states and two of the territories.

Settlement to Spur Drilling

LONG BEACH.—Now that the tidelands revenue fight has been settled, Long Beach is expected to be the scene of extensive drilling in the near future.

The unexplored area in which operators are interested is the 4½ miles between Rainbow Pier and Seal Beach.

Both houses of the California legislature have approved a compromise bill giving the state $120,000,000 of the $171,000,000 in oil and gas revenues from Long Beach tidelands.

Contractor Hunts Oil for Another On His Own Land

ODESSA.—Mineral rights didn't interest Carl B. King Drilling Co. when it bought a warehouse and equipment site 3 miles east of here more than 15 years ago.

The 20-acre tract, and most of Ector County as well, was condemned for oil production then. "Anyone buying mineral rights in the area at that time would have been thought crazy," a company official recalls.

That was before the deep Devonian and Ellenburger discoveries changed the picture.

Now, Carl B. King Drilling finds itself the contractor on a test on its own land, just a stone's throw from the warehouse from which the above photo was snapped. The operator is Carlton Beal & Associates, Midland. Now drilling at 11,770 ft., the well is projected to 12,200 ft. in the Devonian. Location is believed on the west side of the Headlee pool trend.

If oil is found, King has the consolation of owning a small interest. Besides, even if the company had been interested in the minerals, it would have been out of luck. Most of the rights had been retained in previous deals.

Rank Wildcat Hits

Sunray's modest strike is 20 miles from production

BASTROP, Tex.—Sunray Mid-Continent Oil Co.'s much-watched deep wildcat 15 miles northeast of here in northeastern Bastrop County was completed last week as a small oil discovery.

Drilled to 9,800 ft., reportedly in the Lower Cretatceous-Sligo formation, the I Mollie Holme was completed in a Navarro sand, perforated at 4,474-85 ft. It is one of the deepest tests ever put down in Bastrop or any adjoining county in this Southwest Texas area.

The Navarro pay was the shallowest of six zones tested. The deepest, getting a small gas flow with an oil scum, was at 9,512-36 ft.

Potential, location . . . Completion was on the pump with a potential gage of 30 bbl. of 43.1°-gravity oil with 11.67 bbl. of water per day.

Location is more than 20 miles from nearest production at the northeastern extremity of the Balcones fault trend of fields. It is 4 miles north of Paige and about 1¼ miles from the Lee County line. Skelly Oil Co. is associated with Sunray Mid-Continent in the operation.

Little Inch Fight Renewed

WASHINGTON.—The long-fought conversion of the Little Inch pipeline from gas to products service comes up for another round before the Federal Power Commission this week.

The FPC, which last June granted Texas Eastern Transmission Corp.'s application to retire the line from gas service, is making a new study under orders from the federal Circuit Court of Appeals to which Mississippi-Ohio river barge operators carried their fight against the conversion.

The controversy will be tagged on to hearings on an application by Texas Eastern for authority to build new line to expand the capacity of its system by some 250,000,000 cu. ft. daily and to import gas from Mexico.

When the hearings on the new facilities are closed, the FPC will make a decision whether the company should be allowed to retire the Little Inch from gas service. If the decision is favorable to the company, the commission then will have to consider the effect of retirement of the line upon future expansion of Texas Eastern's system, as well as public policy matters arising out of its proposed operation for oil products, as ordered by the court.

British Face New Threat

Iran renews claim to Bahrain and Yemen opposes plan for Aden federation; both moves involve Middle East oil spots

BRITISH influence in an already politically troubled Middle East was challenged on two new fronts last week. In both cases major oil refining centers are involved, but only one is British.

Close observers of the Middle East are inclined to discount the seriousness of both incidents. They apparently are the latest nationalistic efforts to weaken the British hold on the oil-rich area where she has been the dominant force for more than 100 years.

The new British headaches were:

. . . **A renewed formal claim** to Bahrain made by Iran. Bahrain has been a British protectorate since 1880. American-owned oil interests operate its oil industry.

. . . **A British plan for an Aden** federation was challenged by Yemen. The Aden protectorate is a collection of small shaikhdoms which surround the British crown colony of Aden. The colony has existed for almost 120 years.

The Iranian claim . . . Dr. Ali Gholi Ardalan, Iranian foreign minister, made his nation's claim to Bahrain last week in a press conference in Teheran. He said Iran's position has already been made clear to Selwyn Lloyd, the British foreign secretary.

Ardalan said his government cannot recognize Bahrain as an independent British-protected shaikhdom because "this island is an inseparable part of Iran." He said he hopes Iran and Britain can settle the question "amicably."

Four islands make up the archipelago and the shaikhdom of Bahrain. The largest of the islands, Bahrain, is 250 sq. miles in size and is only 20 miles from the coast of Saudi Arabia. It is about 150 miles from Iran and on the opposite side of the Persian Gulf.

The oil-producing concession in the shaikhdom has been held since 1930 by Bahrain Petroleum Co., Ltd. (Standard Oil Co. of California and The Texas Co.). The two producing fields operated by Bapco have been pretty well stabilized at about 30,000 bbl. daily since 1948. The company's 186,500-bbl. daily refinery is one of the largest in the Eastern Hemisphere.

The British position . . . The British foreign office commented last week that it rejected a similar claim on the part of Iran in 1928 and said its stand today has not changed.

London newspapers last week printed reports from Teheran indicating a concerted press campaign promoting the Iranian claim to Bahrain was timed to coincide with the meeting of the Baghdad pact council. British papers said the Iranian press is trying to obtain the support of Iraq for Iran's claim.

The Yemen move . . . Mohamed el Emary, the Yemen deputy foreign minister, disclosed last week that his country will try and get the Arab League to use its power to balk British efforts to form a federation of the loosely-knit Aden shaikhdoms. He called the British plan a serious threat "to the security and peace of southern Yemen." Yemen regards the Aden protectorate as southern Yemen.

The Yemen official said in Cairo that the people and the shaikhs of the protectorate are opposed to the federation plan. He said the area covered by the protectorate should be "returned to the Yemen motherland" or "live in true freedom and independence."

Yemen plans to put the question to the membership of the Arab League at its next meeting in Cairo. Emir el Badr, the Yemen crown prince, was reported in Riyadh last week discussing Yemen's position with King Saud of Saudi Arabia.

One of British Petroleum Co., Ltd.'s largest and busiest refineries is located in the 75-sq.-mile crown colony of Aden, which is separate and apart from the 115,000-sq.-mile protectorate on the Arabian Peninsula at the southern end of the Red Sea. The 120,000-bbl. daily refinery went on stream in July 1954. In its first year it processed more than 25 million barrels of crude.

B.P. announced just last month that it will add a new 8,000-bbl.-daily thermal reformer to the refinery, the first new process unit since the installation was built *(The Oil and Gas Journal, March 26, page 90)*.

The latest Yemen move follows closely another territorial protest involving Britain.

It was just 2 weeks ago that Yemen protested the fact that D'Arcy Exploration Co., Ltd., (British Petroleum) has been granted an oil exploration concession on the Kamaran Islands in the southern part of the Red Sea off the Yemen coast. The islands are administered by the Aden Protectorate, but claimed by Yemen *(The Oil and Gas Journal, April 9, page 82)*.

Reds Boost Octanes All the Way to 66

RUSSIAN refineries have boosted the average octane number of automobile gasoline from 56 to 66, according to M. A. Yevseyenko, U.S.S.R. Minister of the oil industry.

The move followed Nikolai Bulganin's criticism last year that the Soviet Union's 55-octane everage was far below the 72-86 average in foreign countries.

Yevseyenko said that the quality of Russian diesel fuel is still unsatisfactory due to lack of "hydropurifying" and depariffination equipment. He disclosed that diesel fuel made from sulfurous crude during the summer has a 1.2 per cent sulfur content and a pour temperature of zero degrees centigrade.

Russian Exports Fall

Decline caused by lower oil shipments to Finland

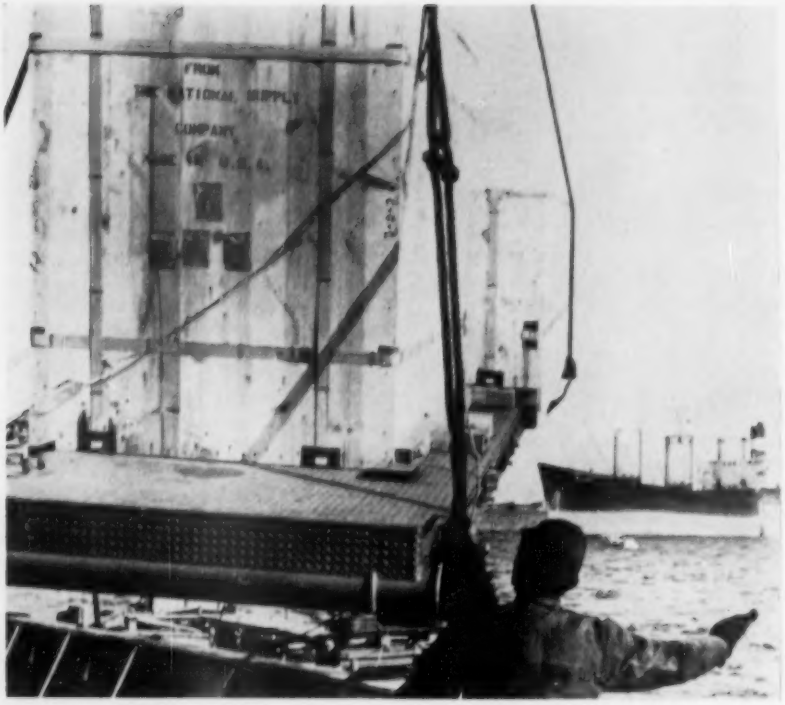
RUSSIAN oil exports to Western Europe declined slightly during the first half of 1955 from the previous years.

Official figures released by the U. S. S.R. Ministry of Foreign Trade show that oil and oil-products export to non-Communist nations totaled $24,816,750 for the first 6 months of 1955. They amounted to $55,783,500 for all of 1954.

Russian oil exports to Italy, Iceland, and Greece showed substantial increases, but these were more than offset by sharply lower shipments to Finland. No Soviet petroleum exports to Belgium, the Netherlands, Denmark, Turkey, or West Germany were shown for the period.

First-half Russian oil exports for 1955 by countries, with all figures converted from rubles into dollars at the official rate of four to one, are:

Finland, $7,499,000; Sweden, $6,885,500; Iceland, $3,355,500; France, $2,549,750; Italy, $2,445,000; Greece, $1,459,250; England, $432,500; Norway, $182,250; and Switzerland, $8,000.



DRILLING EQUIPMENT that will drill the deepest wells in Japan's history arrived recently in Yokohama. The equipment will be used by Teikoku Oil Co.

Deep Drilling Planned in Japan

WILDCAT drilling that will double Japan's drilling-depth record of 5,580 ft. may begin this spring. Some of the drilling may be offshore.

Eyeing the deeper-drilling prospects, Teikoku Oil Co. has bought a National Supply Co. Type 110 rig. It's the first complete rig purchased by the Japanese industry since 1937.

The program stems from geological and geophysical studies made by American technicians during the Allied occupation. Teikoku later expanded these studies and is reported to have found numerous oil-bearing structures at deeper levels.

When the decision came to drill below 12,000 ft., Japan's government authorized the issue of import licenses and dollar exchange to ease the rig purchase.

Japan's deepest well, 5,580 ft., is in Northwest Honshu's Yabese field, which was discovered in 1934. Depths in the country's seven other fields range from 650 to 4,270 ft. The oldest field, Higashiyama, was discovered in 1893.

For years, Japanese production was controlled by refining firms unwilling to assume the risks of exploratory drilling. Before World War II, the government established Teikoku, under an ownership half private and half government.

Early this year, Japanese Petroleum Exploration Co., Ltd., was created for wildcatting operations. The firm is owned half by the government and half by a consortium which includes Teikoku. However, it appears Teikoku will use the new rig within its own area of operations.

Besides the Type 110 draw works, the rig includes a four-section drive group with PTD-6 engines and Gyrol fluid drive, two G700 pumps, an MS-20½-in. rotary, a 648-TU crown block, a 548-TC traveling block, an N-815 swivel, and a Type D line anchor.

Borneo Leases Electrified

British Malayan Petroleum Co., Ltd. (Royal Dutch-Shell), plans to install two gas-turbine electric generators with a combined output of 9,500 kw. at Seria field, Brunei, British Borneo.

The $3,300,000 power expansion program over the next 2 years is necessary because the company is electrifying its lease gathering facilities and has installed cold storage facilities for food.

One of the gas-turbine units will be purchased in the United States and the other in Great Britain. The first, a 5,000-kw. unit, is expected to be operating next year. The other, to generate 4,500 kw., will be installed in 1958.

Union Plans Offset

Costa Rican wildcat cuts second, deeper pay zone

UNION OIL CO. is getting ready to drill an offset to its Costa Rica wildcat which promises to become Central America's first oil producer.

The 1 Cocoles has encountered another good oil show, this one at 6,400 ft., the company reported. When the the operator determines the extent of the new zone, it will be sealed and drilling will continue to 10,000 ft. The shallower pay, found at 5,450 ft., was 114 ft. thick.

Union said the deeper show recovered oil of "excellent quality" and had "unusually high gas pressure." The well is located only a mile from the border of Panama.

Petroleum law studied . . . Amid the excitement of the strike, the Costa Rica Legislative Assembly moved to write a law governing the granting of exploration and exploitation concessions.

Costa Rica has no petroleum law. Union's license, covering extensive areas in the northwest and southeast parts of the country, was obtained under a special contract with the government, approved by the assembly.

The deal calls for Union to turn back all but 150,000 hectares (370,650 acres) of the concessions once oil is discovered in commercial quantities. The indicated discovery is located in the southeast part of the country.

The government is in a hurry to get a petroleum law enacted to be prepared to handle applications for rights in the areas which Union must relinquish.

Legislators are now using the laws of Venezuela and Guatemala as a guide in drafting a code for Costa Rica.

Socony Expanding Refinery

The West German affiliate of Socony Mobil Oil Co., Inc., is expanding the capacity of its Bremen-Oslebshausen refinery to about 25,000 bbl. daily.

Deutsche Vacuum Oel, A.G., is adding a two-stage distillation plant, a 3,200-bbl. daily catalytic reformer using Socony Mobil's Sovaforming, and a 4,800-bbl. daily diesel-oil desulfurizer using the Sovafining process. Other facilities will include a sulfur plant and 346,000 bbl. additional tankage.

Expansion is due to be completed in 1957. The present capacity of the refinery is about 15,300 bbl. daily. There is 7,800 bbl. daily catalytic cracking capacity and the plant can process 1,100 bbl. daily of lubricating oil.

Cuban Job Started

● Esso building refinery to process Venezuelan oil; two other plants under way

ESSO STANDARD OIL CO., S. A., is building a 35,000-bbl. daily refinery on the site of its ancient Belot, Cuba, plant which is largely being scrapped.

C. J. Griffin, general manager of the Standard Oil Co. (N.J.) Cuban subsidiary, said the $30,000,000 program is expected to be completed in the last quarter of 1957. The new facilities will be built on a 192-acre site, located across the bay from Havana. At present, the Belot refinery has a capacity of 8,500 bbl. daily.

Two other refineries are under construction in Cuba. Cie. Petrolera Shell de Cuba started work on a 25,000-bbl. daily plant on Havana Bay last year. It is expected to go on stream late this year. The Texas Co. started building a 20,000-bbl. daily refinery in November at Santiago de Cuba, at the opposite end of the island. It will go into operation early in 1957 *(The Oil and Gas Journal, November 21, 1955, page 134; August 22, 1955, page 91).*

The refineries will give Cuba a capacity of more than 80,000 bbl. daily, making the island self-sufficient for most of its product needs. Consumption last year averaged 53,400 bbl. daily, compared with 14,500 bbl. daily in 1937. The refinery projects took shape after the Cuban Government issued a decree in 1954 designed to encourage foreign capital to invest in the country.

Refinery units . . . The Belot refinery will have units for catalytic cracking, Hydrofining, Hydroforming, polymerization, and light-ends recovery.

Present process and treating facilities will be torn down. But storage tanks, offices, ovens, and other auxiliary equipment will be saved. A large new marketing terminal also is being built.

The new units will be designed to use Tia Juana medium crude from Venezuela. Cuba produces only 1,500 bbl. daily.

Arthur H. McKee Co. has the contract for process and treating equipment. Raymond Concrete Pile Co. will participate under a joint-venture relationship. Cuban contractors will handle earth moving and construction of shops, docks, fences, etc.

The Belot refinery has been on stream since before the turn of the century. In 1898 its capacity was 300 bbl. daily. By 1911, the capacity rose to 2,900 bbl. daily and has been increased gradually since then.

Synthetic Rubber Boom Spreads

Europe's first large-scale production seen by 1958 when petrochemical plants go on stream in France and Britain

THE two major synthetic-rubber processes will be used for the first large-scale production of synthetic rubber in Europe.

Both Britain and France expect to have plants in operation in 1958. The two will use different processes, but at least a part of the capital for the two plants will come from the same sources.

In France . . . The French plant, a 20,000-ton butyl-rubber installation, will be built at Port Jerome near LeHavre. It will be the fourth butyl plant in the world.

Esso Research & Engineering Co. invented the process for making rubber from refinery gases. Esso has granted a license to a new French company, Ste. du Caoutchouc Butyl (SOCABU), formed by 10 French firms to build the plant. Esso Research & Engineering said last week it has also licensed the new firm to use its technique for recovering isobutylene from refinery gases.

The companies which organized SOCABU are Cie. Francaise de Raffinage, S.A. (C.F.R.); Manufacture Francaise des Pneumatiques Michelin, Puiseux Durin et Cie. (Michelin); Esso Standard S.A.F. (Jersey Standard); Ste. des Pneumatiques Dunlop, S.A. (Dunlop); Pneumatiques et Caoutchouc Manufacture Kleber Colombes, S. A.; Etablissements Kuhlmann, Manufacture de Produits Chimiques du Nord, S.A.; Ste. des Usines Chimiques Rhone-Poulenc, S.A.; Ste. Industrielle de Produits Chimiques, S.A.; Cie. de Produits Chimiques et Electrometallurgiques Pechiney, S. A.; Ste. d'Electro Chimie, d'Electro'Metallurgie et des Acieries Electriques d'Ugine, S.A.

Several of them are automobile tire manufacturers and two, C.F.R. and Esso, operate refineries in the Port Jerome-Gonfreville area of France and will furnish the plant with its isobutylene raw material.

In Britain . . . The British installation will be a butadiene plant with a capacity of 50,000 tons a year.

This output is just about the amount of synthetic rubber which the United Kingdom imports from the United States at the present time.

The British installation actually will be two plants. Esso Petroleum Co. plans to spend more than $25 million on a butadiene plant at its 150,000-bbl.-daily Fawley refinery. The butadiene will be fed to a new $14-million GR-S plant on an adjacent site which will be built by International Synthetic Rubber Co.

International Synthetic Rubber was formed last year by Britain's four major tire manufacturers—two of whom are interested in the French butyl plant. The four are Dunlop Rubber Co., Goodyear Tire & Rubber Co., Firestone Tire & Rubber Co., and Michelin Tire Co.

International BRIEFS

A gas field has been discovered in the Upper Rhine Valley near Darmstadt, West Germany. The discovery well, 1 Grob-Gerau, tested 700,000 cu. ft. daily from the Tertiary between 1,585 and 1,675 ft. Drilled by Gewerkschaft Elwerath, the discovery is about 9 miles north of Stockstadt oil and gas field.

Deutsche Shell A.G. has put the first of two Platformers at its 19,500-bbl. Hamburg-Harburg refinery into operation. The U.O.P. unit has an intake capacity of about 2,300 bbl. daily of naphtha.

Detachments of the Burmese Army are escorting geological parties surveying the Irrawaddy Delta this spring. One job of the troops is to keep a watchful eye on dynamite supplies used for seismic shooting. Exploration work had been delayed for several years because of near civil-war conditions in many sections after World War II. Burma Oil Co. (1954), Ltd., this year may drill the first wildcat in Burma since before the war *(The Oil and Gas Journal, March 26, page 92).*

Bahama California Oil Co. and Bahama Exploration Co. this week will launch a joint marine seismic survey of the 1,700-sq. mile Cay Sal area, 200 miles southwest of Nassau. The survey, expected to take 2 months, will be made by Western Geophysical Corp. under supervision of Bahama California, a subsidiary of Standard Oil Co. of California. Bahama Exploration is a Gulf Oil Corp. subsidiary.

Besides their joint interest at Cay Sal, Standard of California and Gulf hold other concessions independently in the area.

Beginning . . . a special section on

FIELD PROCESSING - 1956

A 10-Part Discussion . . .

1. Absorption section.
2. Distillation section.
3. Two arrangements of fractionator train.
4. Compressor control - protective devices.

STATUS OF:

5. Force-balance transmitters.
6. Electronic controllers.

RECENT DEVELOPMENTS:

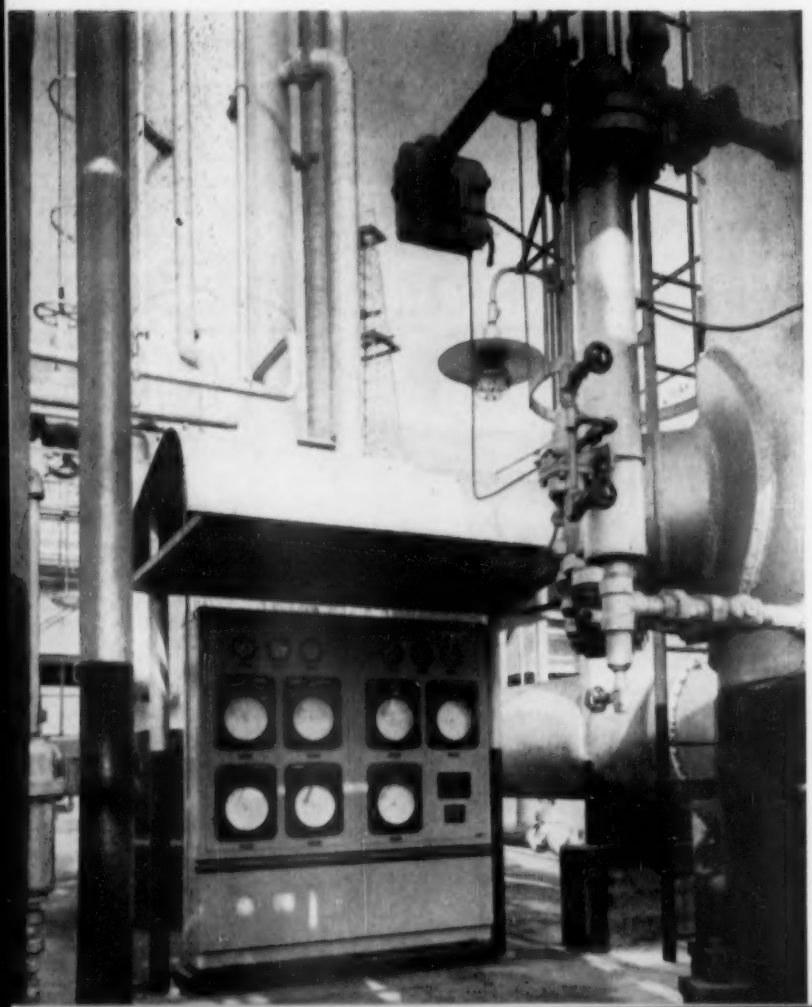
7. Deisobutanizers - differential v.p. control.
8. Bollaway recorders.
9. Rich oil power recovery.
10. Absorber gas power recovery.

Natural-Gasoline and Cycling-Plant

INSTRUMENTATION

As processing has become more complex, methods of controlling it have kept pace . . .

by E. E. Kleir



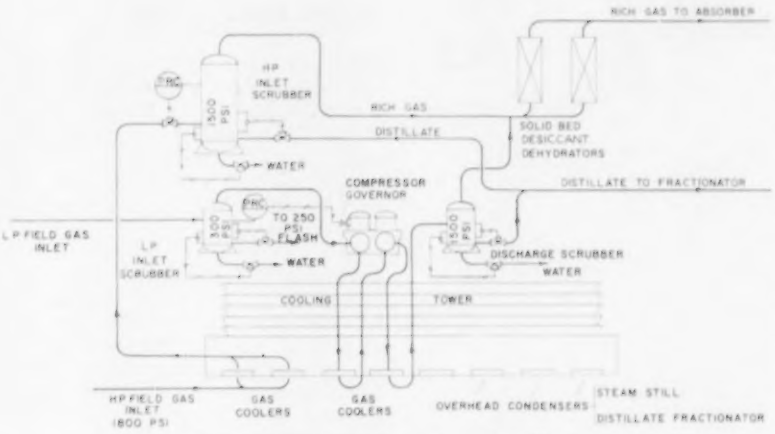
LOCALLY LOCATED PANEL at Colline Gasoline Corp., Rincon field, Ventura, Calif. Fig. 1.

EARLY gasoline - plant instrumentation was primitive by today's standards; just a few simple direct-connected instruments, mounted out in the open at the point of measurement on the equipment. As the complexity of plant operation increased, instruments were added and the local groupings grew more congested.

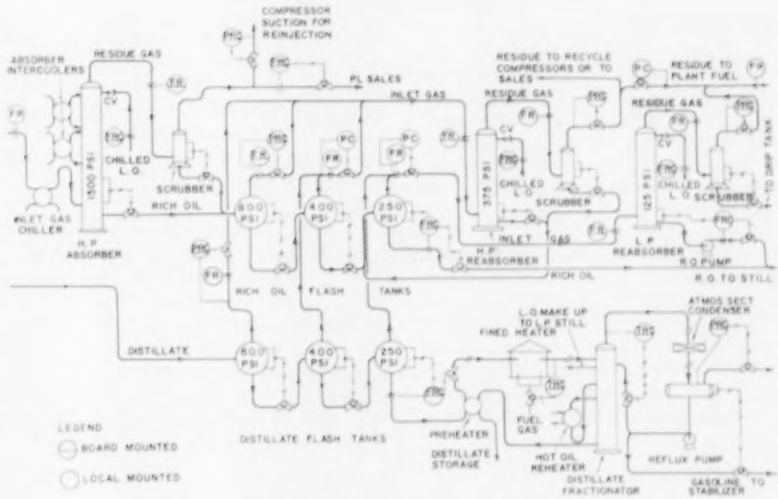
Control Boards

Since equipment like pumps and compressors was housed in buildings, the trend was to a central instrument control board. To reduce initial building cost the board was housed at one end of the pump building. The instruments continued to be directly connected, but in many cases the distances between the instruments and the points of measurement were really too great for entirely satisfactory results. Too much attention was necessary to keep them in operation.

The introduction of pneumatic transmission offered a solution to the vexing problem of direct measurement over long distances. With such a system, accurate measurement is made at the



TYPICAL GAS ENTRY to absorption. Fig. 2.



TYPICAL absorption section. Fig. 3.

required location in the plant and a pneumatic signal proportional to the measurement value is transmitted, up to 1,000 ft., to a measurement receiver-controller on the central control board.

Central and local . . . Lately there is a trend in the larger plants to compromise between central and local instrument grouping using pneumatic transmission on temperature and flow. Each instrument group is associated with some part of the process such as absorbers, reabsorbers, and stills. To a large extent it was the desire on the part of management to encourage regular operator patrol of plant equipment such as flash tanks, scrubbers, feed drums, and liquid levels. Where pressures of the order of 1,500 to 2,000 psi. are employed, as in the absorber section of modern recycle plants, this supervision becomes important. To afford some protection during wet weather, outdoor panels are provided with an overhead canopy, as shown in Fig. 1.

The intsruments associated with the fractionation processes are usually mounted on panels indoors. More supervision is required for this part of the process because it produces the final key products, and upsets are critical.

Graphic Panels

The logical question is: Why not have all instruments on a central panel and still stay within space requirements by using small-surface-area instruments?

A graphic panel is a flow diagram of plant operation with major operational components such as fractionators, reboiler, heat exchangers, surge tanks, absorbers, and control valves, symbolized for easy recognition and with major operation flow lines indicated in color coding. All principal instrumentation appears on the panel in the flow diagram at the point where it is functioning in the operating system.

Small surface areas . . . To accommodate instrumentation in such a layout without having the panel excessively large, instruments were designed with small surface areas in the order of 18 to 36 sq. in. compared with the standard rectangular case area of approximately 235 sq. in. Functionally the smaller instruments are equal to their larger counterparts.

To produce recorders in the smaller-area instruments it was necessary to use strip charts because a circular chart requires a space of more than twice its measurement scale length in all directions for its center. In designing a suitable strip chart the scale length can be the same as the scale length on a 12-in. circular chart. Nothing need be sacrificed in readability or calibrated accuracy.

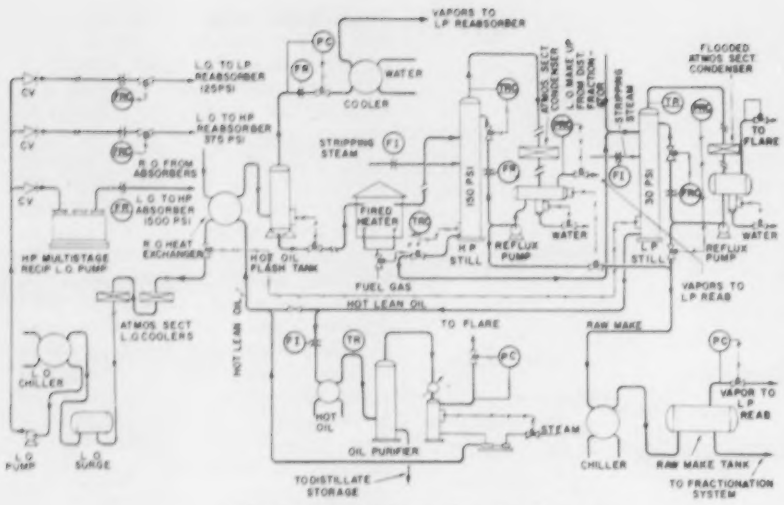
Field Processing

L.P.G. is derived chiefly from three sources: (1) gasoline plants recovering hydrocarbons from formation gas separated from crude oil at the well head, (2) recycle plants recovering hydrocarbons from gas-distillate wells with the stripped residue injected into the field reservoir to pick up additional wet fractions, (3) refineries, where it is recovered from tail gases and termed L.R.G.

One method of recovering L.P.G. is by compression. However, the most common method is liquid absorption. There are many different absorption-type natural-gasoline processes. At the risk of over-simplifying, several flow sheets are shown which represent key sections typical of recycle plants. With the exception of operating at higher pressures they are identical with those in the average gasoline plant. For brevity, some key equipment such as reboilers, refrigeration system, oil-fired heater, recompressors, and gasoline stabilizers is omitted.

THE AUTHOR

E. E. Kleir is Gulf Coast regional engineer with Foxboro Co., at Houston. He received a degree in mechanical engineering from Iowa State College in 1929. His first position was with Ingersoll-Rand Co. at Phillipsburg, N. J., and New York City, from 1929 to 1935. Since 1935 he has been with Foxboro in its Chicago, Tulsa, and Houston offices. He is a member of the Instrument Society of America, and past secretary and program chairman of I.S.A., Houston section. He is a member of Tau Beta Pi, national honorary engineering fraternity and Sigma Upsilon, the literary fraternity, and has contributed articles to I.S.A. Journal and The Oil and Gas Journal on petroleum subjects. The article appearing here was presented at the I.S.A. conference in Los Angeles.



TYPICAL distillation section. Fig. 4.

1. Absorption Section

Purpose of the absorption section is to extract the desirable hydrocarbons, propane and heavier, from the inlet gas, and reject the lighter fractions of methane and ethane. Typical gas entry to the absorption section is shown in Fig. 2.

High-pressure field gas . . . This gas at 1,800 psi. passes through gas coolers in the cooling-tower base to the high-pressure scrubber in which the pressure is controlled at 1,500 psi. Distillate and water leave the bottom of the scrubber and rich gas goes overhead to the dehydrators.

Where the field gas is predominantly sour, the gas dehydrator is preceded by an amine unit (not shown in the diagram) for removing the hydrogen sulfide to meet sales-gas specifications.

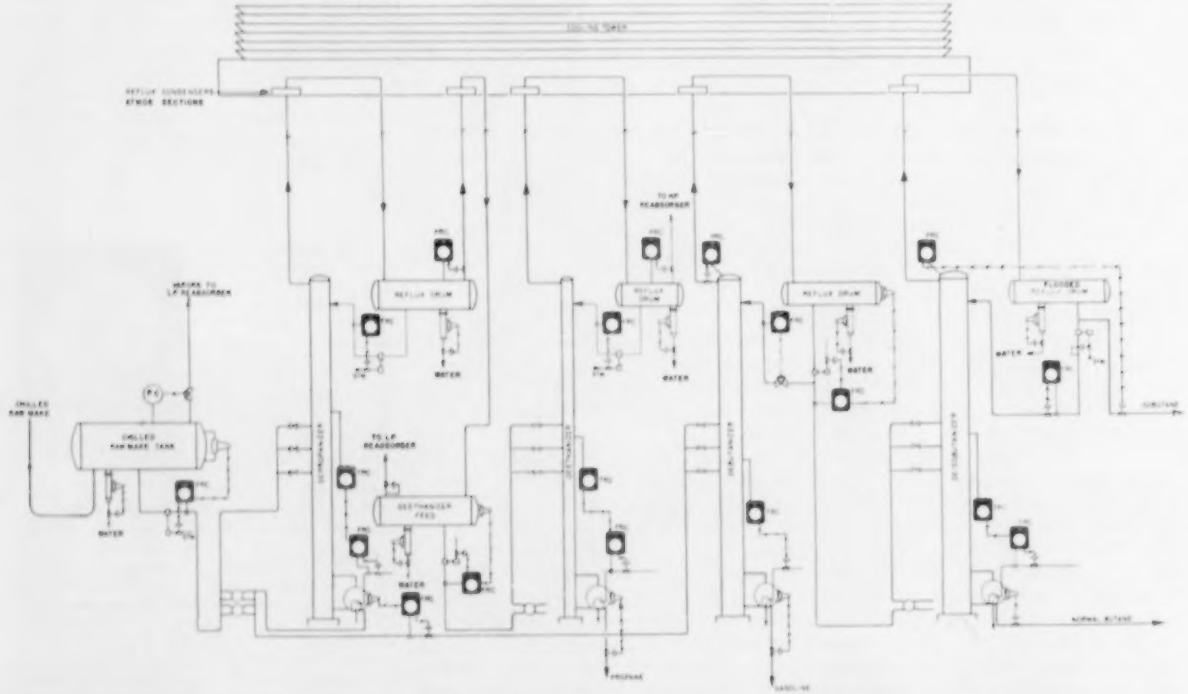
Recycle plant . . . The flow diagram shown in Fig. 3 is typical of many recycle plants for high propane recovery. The rich gas from the dehydrators passes through the chiller and enters the bottom of the high-pressure absorber where it flows upward, countercurrent to chilled lean oil entering at the top at a controlled rate of flow. The high-pressure absorber is the key piece of equipment in the unit. Some of the factors affecting absorber efficiency are: (1) ratio of lean oil to rich gas, (2) oil and gas temperature, (3) type of absorption oil used; and (4) absorber pressure.

Field Processing

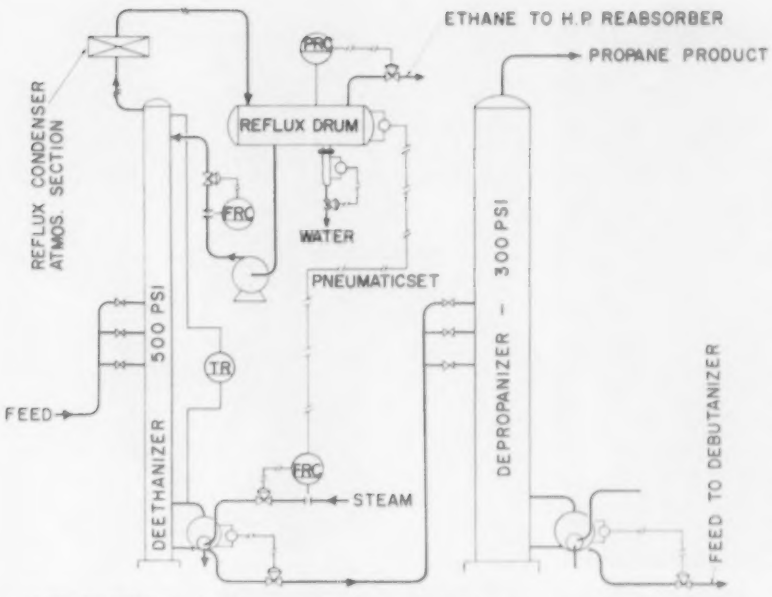
Quantity of HC's absorbed . . . The rate of flow of rich gas to the absorber is measured ahead of the chiller; the rate of flow of absorber residue overhead gas is measured ahead of the scrubber. The difference between the two measurements is the quantity of hydrocarbons absorbed, and the figure is used in establishing an absorber material balance.

Gas from the residue scrubber splits two ways; one stream goes to the recycle compressors, not shown, for reinjection to the field reservoir. The suction pressure to the recycle compressors is usually controlled as shown. The other stream goes to the pipeline under flow control.

Flashing . . . The dissolved hydrocarbons in the rich oil from the bottom of the absorber consist of large quantities of methane and ethane as well as the desirable propane and heavier components. The methane and ethane must be released without losing the desirable components. Flashing is carried out in a series of flash tanks,



TYPICAL FRACTIONATION SECTION. Lead column, though labeled "depropanizer" is actually "deethanizer-depropanizer." Fig. 5.

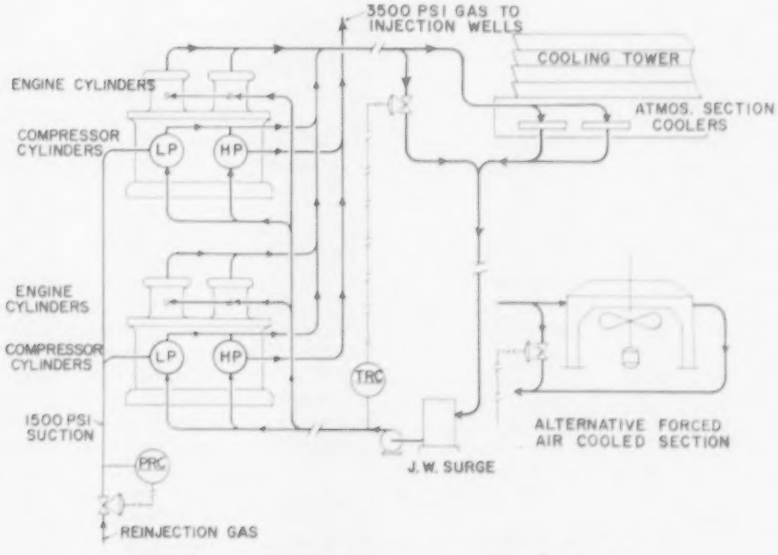


ALTERNATIVE deethanizing-cascade system. Lead column is true deethanizer. Fig. 6.

with pressure in each stage approximately one-half of the pressure in the preceding stage. This flashing operation makes it possible to carry out later fractionation at much lower pressures.

The oil entrained in the overhead gas from the absorber is drawn from the bottom of the scrubber, under liquid-level control. It combines with the rich oil flowing from the bottom of the high-pressure absorber, under liquid-level control and enters the first-stage flash tank. The pressure is controlled in this tank at 800 psi. by the release of flash vapors consisting principally of methane with some ethane. The flow recorder in the vapor relief line is essential as a check on the absorber operation; any unusual changes in the rate of flow of relief vapor indicates an upset in the absorber.

The rich oil is drawn from the bottom of the first-stage flash tank under liquid-level control and enters the second-stage flash tank, where the pressure is controlled at 400 psi. and the relief vapor flow recorded with instruments similar to those on the first stage. The combined vapors from the first two flash tanks go to the high-pressure reabsorber where the operation is similar to that in the high-pressure absorber. Residue gas from the



TYPICAL compressor jacket water temperature control. Fig. 7.

Field Processing

scrubber goes to the recycle compressors or to sales and to the plant fuel makeup, as indicated.

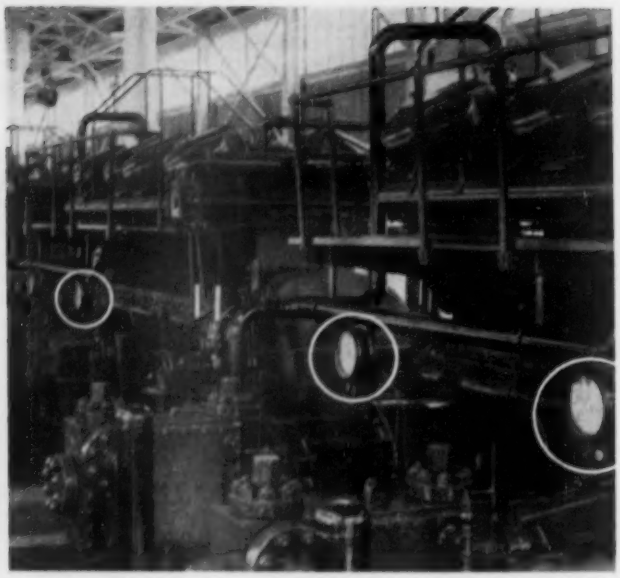
The rich oil is drawn from the second-stage flash tank under liquid-level control and enters the third-stage tank in which the pressure is controlled at 250 psi., and the relief vapor flow is recorded with instruments similar to those on the first and second stages. The vapors from the third stage tank enter the low-pressure reabsorber and the overhead residue gas goes to plant fuel.

Pneumatic set . . . The rich oil from the third-stage flash tank combines with that from the low-pressure reabsorber as rich-oil charge to the distillation section. To minimize upsets in the distillation section which may be caused by variations in rich oil flows, the flow controllers in each line are pneumatically set from the respective level controllers, on the third-stage flash tank and the bottom of the low-pressure reabsorber.

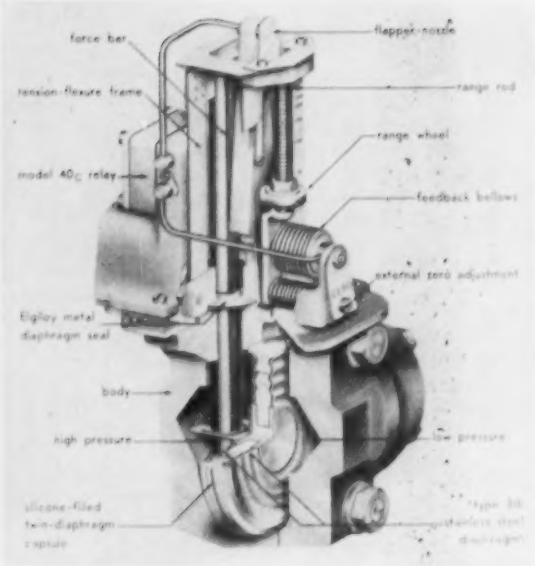
Low-pressure gas . . . In addition to high-pressure field gas there is invariably a source of low-pressure gas which in Fig. 2 is shown entering the same type of scrubber as the high-pressure inlet scrubber. The pressure is controlled at 300 psi. by controlling the speed of the gas-engine-driven compressor. The discharges from each stage of the compressor are inter and aftercooled in atmospheric sections at the cooling-tower base. For brevity, the interstage scrubber is not shown. The gas from the compressor discharge scrubber combines with the rich gas from the high-pressure inlet scrubber ahead of the dehydrators.

The distillate drawn from the compressor discharge scrubber under liquid-level control combines with the distillate from the high-pressure inlet scrubber under level control and enters another series of flash tanks as shown in Fig. 3. The liquid-level controller on the 250-psi. flash tank in this series pneumatically sets a flow controller in the distillate line to the heater in order to assist in stabilizing the temperature control of distillate leaving the heater. The distillate stream then enters the distillate fractionator where the overhead product is gasoline to the stabilizer. The stabilizer is not shown in this diagram.

The temperature of the overhead vapors from the distillate fractionator is regulated by controlling the venting of vapors from the reflux accumulator with a pressure-recording controller. It is frequently desirable to include a hot-oil reheater or reboiler in the sys-



INSTALLATION of safety shutdown controllers operating on compressor stuffing-box temperature. Fig. 8.



NEW MODEL of force-balance type of flow transmitter (d/p cell). Fig. 9.

tem. This is usually heated from a separate source. The bottom product from the distillate fractionator exchanges heat with feed to the distillate fractionator on its way to storage.

Other Process Cycles

Although this absorption flow sheet is typical of many recycle plants operating today, it does not represent plants of more recent design in which the system of flash tanks and the high and low-pressure reabsorbers are eliminated. Instead, the high-pressure absorber sometimes flashes directly into a low-pressure absorber, then through a single flash tank and into a rich-oil demethanizer. Residue from the high-pressure absorber is recycle gas to reservoir reinjection. Low-pressure absorber residue is pipeline sales. Residue from demethanizer is plant fuel and oil from the demethanizer bottom is rich oil to the distillation section.

2. Distillation Section

In the distillation section the rich oil from the absorption unit is stripped of the desirable hydrocarbon fractions and returned as lean oil to the absorbers. Fig. 4 shows a typical distillation section.

Rich-oil flash . . . The rich oil from the absorption section passes through a heat exchanger and enters a hot-oil flash tank. A pressure controller in the vapor relief line from the flash tank controls the tank pressure and a flow recorder measures the vapor flow. The relief vapors pass through a water cooler and are recycled to the low-pressure reabsorber. The bottom stream under level control from the flash tank goes through a fired heater to a high-pressure still. A temperature controller maintains a uniform temperature of the stream leaving the heater by controlling fuel gas to burner.

High-Pressure Still

The temperature of the overhead product from the high-pressure still is controlled by a temperature controller with the valve in the reflux line, and the flow of reflux to the still is measured by a flow controller. The condensed product represents one stream of the raw material to the fractionation section. The pressure controller on the reflux accumulator vapor relief line maintains a constant pressure of 150 psi. on high-pressure still.

Low-Pressure Still

The bottoms from the high-pressure still, under level control, enter the low-pressure still for additional stripping. The overhead product is condensed and becomes a second stream of the raw material to the fractionation system. The temperature of the overhead vapors from the low-temperature still is recorded by a temperature recorder and is controlled by a flow controller in the reflux line. The still pressure is maintained at 30 psi. by controlling the level in the reflux condenser. To accomplish this, a pressure controller in the overhead vapor line operates a valve in the accumulator drawoff line to the raw-make tank. A self-operated back-pressure regulator on the flooded reflux accumulator will vent off any ethane that might accumulate during an upset.

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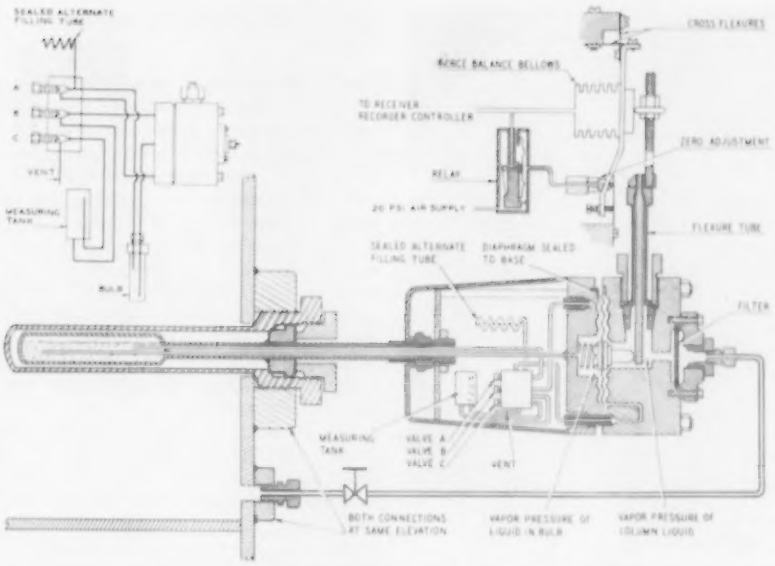
Lean-oil circulation . . . The hot lean oil from the bottom of the low-pressure still, under level control exchanges heat with the incoming rich oil, is cooled in the cooling-tower atmospheric sections, and chilled after leaving the lean-oil surge drum. The chilled lean oil is pumped to the low and high-pressure reabsorbers with flow controllers regulating the rate of flow to each unit. A high-pressure multistage reciprocating pump pumps lean oil to the high-pressure absorber.

Steam stripping . . . To attain complete stripping in the high and low-pressure stills steam is introduced as indicated. For efficent operation, the rate of flow of steam is either controlled manually with a flow indicator or is controlled automatically. The introduction of steam creates additional ebullition in the still and causes easier volatilization and separation of the hydrocarbons from rich oil.

The raw-make product from the stills is cooled before entering the raw-make tank to minimize the loss of the lighter fractions before fractionation. The pressure in the raw-make tank is controlled as shown by venting vapors to the low-pressure reabsorber.

Oil purifier . . . If lean oil to the absorbers is continually recirculated without complete stripping it becomes heavier and it gradually loses its absorption ability. To eliminate this situation a hand valve in the main hot-lean-oil return line from the low-pressure still is throttled to deflect a stream of hot



DIFFERENTIAL vapor-pressure cell transmitter (dVp cell) used in deisobutanizer control by vapor-pressure comparison method. Fig. 10.

INSTALLATION of dVp cell transmitter on tower. Fig. 11.

oil through a heat exchanger to an oil purifier. A flow indicator in the deflected stream shows the flow rate, a temperature recorder in the line from the heat exchanger to purifier is an operating guide, and a pressure controller in the vent line from the accumulator controls the pressure in the purifier. A steam-driven reciprocating pump under liquid-level control returns the purified oil to the hot-lean-oil line beyond the hand valve.

Rate of flow control of the chilled-lean-oil streams to the 375-psi. and 125-psi. reabsorbers is necessary to attain system balance. The rate of flow of high-pressure lean oil to the 1,500-psi. absorber is recorded and manually regulated.

3. Fractionation Section—Two Methods

Time and space are the limiting factors in describing fractionation systems used in the L.P.G. industry. However, the common problem is to attain maximum ethane stripping in the first fractionator with maximum retention of propane and heavier components. Two methods of ethane separation are gradually followed, one of which is shown in Fig. 5.

Ethane-Propane Overhead in Lead Column

The term "depropanizer," applied to the lead tower, is actually a misnomer because both ethane and propane are the overhead product. The advantages claimed for this type of tower are better ethane stripping, less propane loss overhead, and lower equipment cost. However, an additional pump is required to feed the joint overhead product to the next tower which is operating at higher pressure.

The instrumentation on each tower is substantially the same. A temperature controller with measurement at the point of maximum tower (composition) gradient pneumatically sets the control point of a flow controller on the steam to the bottom heater. A flow controller regulates the rate of flow of reflux and the rate of flow of feed to each tower is pneumatically set from a level controller.

The depropanizer overhead is partially condensed in the first atmospheric condenser section and maintains a reflux-drum level necessary for reflux requirements. The uncondensed vapors from the reflux drum are condensed in the final atmospheric condenser section, and the liquid product is the feed to the deethanizer. A pressure controller on the reflux drum controls the pressure in the tower from the rate of vapor relief from the accumulator. In some cases a single condenser and reflux drum serve to supply both reflux and feed to the next tower.

Deethanizer . . . The total condensed depropanizer overhead product is feed for the deethanizer where ethane is the overhead product. A pressure controller on the reflux drum controls the tower pressure by the rate of relief of ethane and all ethane in excess of reflux requirements is relieved to the high-pressure reabsorber. The bottom product of this tower is propane.

Debutanizer . . . The feed to the debutanizer is the bottoms from the depropanizer tower. The overhead products of the debutanizer are isobutane and normal butane which are totally condensed and the reflux drum supplies the reflux requirements and the feed to the next tower. A pressure controller on the top of the tower controls the pressure by the rate of relief of vapors from the tower.

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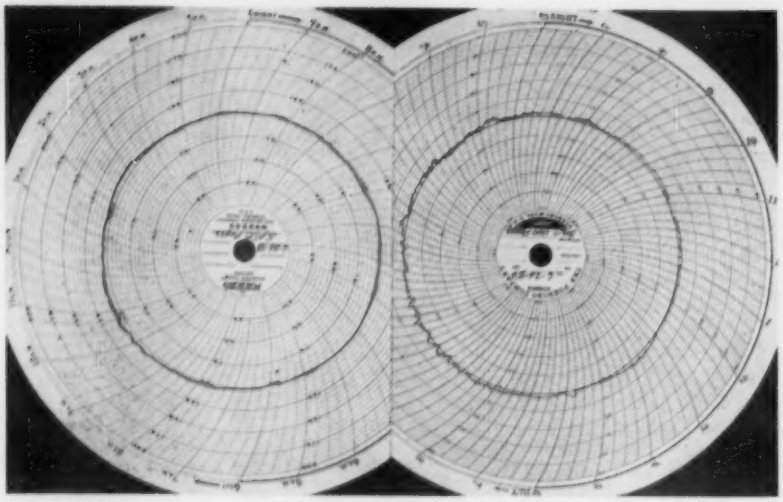
Deisobutanizer . . . The total condensed debutanizer overhead products is feed for the deisobutanizer in which isobutane is the overhead product and normal butane is drawn from the bottom level control to storage. The deisobutanizer pressure is controlled by the rate of condensing the overhead product.

Flooded condenser bundle . . . A pressure controller measures the pressure at the top of the tower and with the valve in the isobutane outlet from the drum the level in the condenser can be varied to affect the condensing surface and thus the condensing rate. If tower pressure increases, the control valve opens, and the level in the condenser drops, increasing the condensing surface until the condensing rate is sufficient to reduce tower pressure to the desired value. The large time constant in this application indicates that rate action is required in addition to the regular proportional plus reset action. However, with this method of control, a much smaller control valve can be used in the liquid than would



BUTANE SPLITTER CHARTS. At left is vapor-pressure chart. At right is chart showing the simultaneous pressure in the tower. Fig. 12.

Field Processing

be required for the equivalent noncondensed vapor.

Alternative Deethanizing—Cascade

Fig. 6 shows another method of separating ethane with a minimum loss of propane and heavier components. This is known as the "cascade" system:

The raw make enters the lead tower, a true deethanizer. The desired overhead product is ethane vapor and the bottom product should be as free as possible from ethane. The product from the bottom is fed under level control to the depropanizer, where propane overhead is the liquid product to storage. The depropanizer bottom is the feed to the debutanizer as in Fig. 10.

Stripping ethane . . . As nothing except vapor-phase ethane is desired from the deethanizer overhead only sufficient propane-ethane mixture is condensed to satisfy the reflux requirements. To accomplish this the reflux-drum level controller pneumatically sets the flow controller in the steam line to the bottom heater. Sufficient heat is provided to carry over enough propane to maintain the reflux-drum level. With this method all ethane is automatically stripped from the bottom product.

Self-regulation . . . The tower pressure is maintained by a pressure controller on the reflux drum regulating the relief of drum ethane vapor, with some propane, to the high-pressure reabsorber. A two-pen temperature recorder is a guide in maintaining the desired temperature difference between the top and bottom of the tower. This control system tends to be self-regulating because only enough heat is applied to the bottom heater to strip off ethane plus enough propane to satisfy the dew-point composition of the condensed material. A variation of the foregoing system consists of a flow controller on the steam to the bottom heater with the reflux flow varied from the reflux drum level controller.

Economics . . . In this method of deethanization the lead tower pressure is high enough so that no pump is required to transfer the bottom product to the succeeding tower. However, as the lead tower pressure is 500 psi. as against 300 psi. in the system shown in Fig. 6, there is a substantial difference in cost between the two towers, which more than offsets the extra cost of the feed pump required under the first method.

In the cascade system the lead tower tends to be less stable insofar as propane loss is concerned, and unless the tower is carefully instrumented, an upset can easily cause entrainment of excess propane and even butanes and pentanes in the overhead vapors. However, these are not irretrievably lost as they will recycle to the reabsorber but, in so doing, they are an additional load on the deethanizer overhead condenser, the reabsorber, and the pumps.

4. Compressor Control

In the larger recycle plants, in which compressors are reinjecting gas at 2,000 psi. and higher, considerable attention is devoted to establishing optimum compressor operation. In addition to pressure control on the compressor suction with the control valve in the suction header, engine and compressor-cylinder water-jacket temperature control is essential.

Control jacket-water temperature . . . A closely controlled correct cylinder-wall temperature minimizes cylinder-wall wear and lube-oil consumption. In some cases, the compressor manufacturer recommends that the inlet jacket water be maintained to within 1° F. On many installations jacket-water coolers are installed as atmospheric sections in the cooling-tower base, forming a closed circuit in which hardness concentration and jacket sealing can be controlled. Where scarcity of water is a problem, forced air-cooled units are used in this service.

Fig. 7 shows a typical compressor jacket-water temperature-control system. In cooling-tower operation the temperature of the water leaving the cooler can vary with the conditions surrounding the cooler such as outdoor temperature and humidity, prevailing wind direction and velocity, and number of tower cells in operation. These variables are beyond the control of the instrument. The jacket-water temperature controller operates a valve in the hot return water bypass around the cooler and adjusts the valve to produce the desired water temperature at the pump discharge.

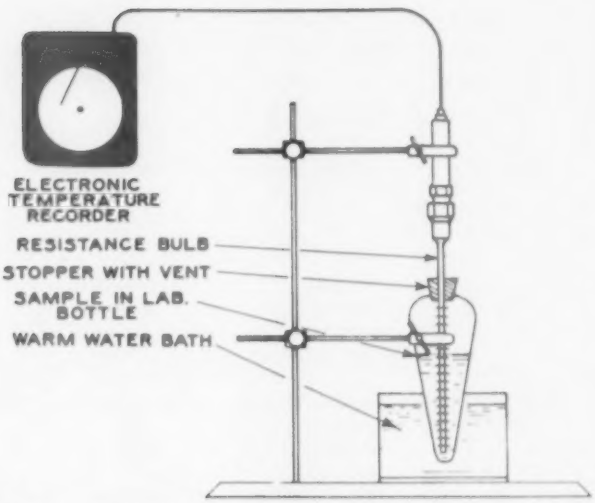
Forced-air cooling . . . Where forced air-cooled sections are used, the hot-water bypass may be arranged as shown. In other cases, the bypass system is eliminated and the temperature controller regulates the cooling by adjusting fan shutters, varying fan speed through a hydraulic coupling, or varying fan-blade pitch.

Proportional-plus-reset . . . Attempts have been made to reduce first cost by using self-actuated temperature regulators but in the majority of cases they have been replaced by instrument-type pneumatic controllers with proportional plus reset action.

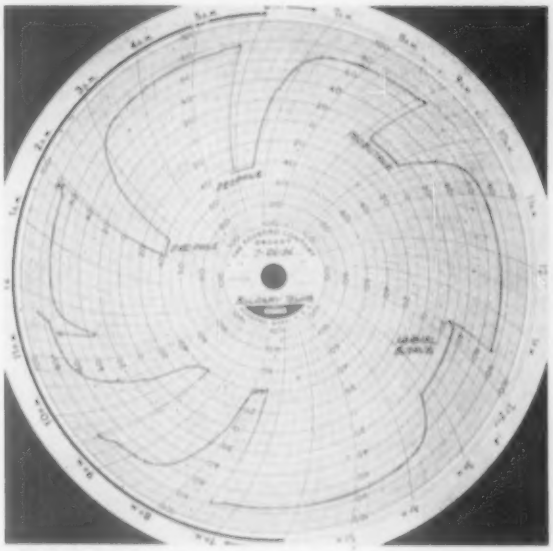
Stuffing Box Temperature Shutdown

A source of potential trouble on high-pressure compressors is the compressor stuffing box. To seal the reciprocating piston rod, the assembly is manufactured to rather close tolerances. They may overheat under heavy load to such an extent that the rod actually seizes, and unless promptly cooled the rod can be scored which may require an expensive shutdown and replacement. Once a stuffing-box assembly starts heating up, the temperatures rises rapidly.

Temperature bulb . . . This problem has been solved in one case by installing a simple filled system temperature controller with on-off action on each com-



BOILAWAY RECORDER for natural-gasoline products weathering test uses resistance bulb. Fig. 13.



TYPICAL BOILAWAY temperatures of gasoline plant products. Fig. 14.

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pressor stuffing box. One of the stuffing-box bolts is removed and the temperature is inserted into the box. When the temperature in the box reaches an established danger point, air pressure from the controller operates a mercury switch which grounds the engine magneto, and stops the unit. These protective controllers are considered so vital that only recorder-controllers with daily charts are used and a second pen is substituted for the usual index pointer in order to have a record of shutdown-temperature setting. Fig. 8 shows an installation of the safety-shutdown controllers that have been in service for over 10 years.

Other engine shutdowns . . . Protective shutdown devices customarily used are: high inlet scrubber level, low suction pressure, high discharge pressure, high jacket-water temperature, low lube-oil pressure, engine overspeed. Except for the last item, the shutdown devices are usually bourdon-tube-actuated mercury switches which trip to close a circuit and ground the engine magneto.

5. Force-Balance Flow Transmitters

Fig. 9 shows a force-balance type of flow transmitter that is fast replacing the motion-balance mercury float-type flow transmitters. Several factors contribute to the acceptance of the force-balance unit including lower initial cost, lower installation cost, less service and maintenance expense, no seal pots required, no mercury required. The close coupling and the high-speed-measurement characteristic contribute materially to improving the performance of all associated controllers.

An example of a well-designed coordinated control system was demonstrated in a gasoline plant, equipped with force-balance flow transmitters. Three weeks after the plant was started, a major disruption occurred in the field gathering system, causing a complete plant shutdown. Four hours after inlet gas had been restored, the plant was back on stream delivering specification products, and the operators had only 3 weeks' training in running the plant. A major portion of the credit for the quick recovery from the major upset is attributed to force-balance transmitters on the key flows.

6. Electronic Temperature Controllers

The electronic temperature recorder and controller eliminates many of the disadvantages of the mechanical temperature instruments on fractionation applications. An electrical resistance temperature bulb generally has faster response characteristics than the filled-system bulbs usually used on these applications and measurement can be made at the desired point in the plant with electric cable connection to the instrument on the central control panel.

Temperature measurement and control on graphic panels is usually by a filled-system force-balance temperature transmitter, similar to the flow transmitter in Fig. 9, mounted in the plant at the point of measurement with the actual measurement transmitted as a pneumatic signal to the recorder-controller on the panel.

7. Deisobutanizers-Vapor Pressure Control

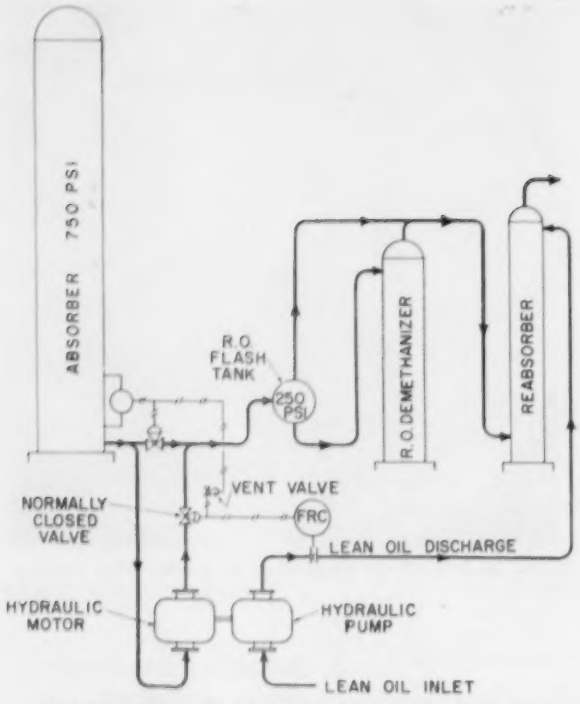
This method of controlling deisobutanizers is rapidly being accepted by the natural-gasoline industry. When correctly applied and supported with correct coordinating instrumentation it has proved to be an excellent means of producing uniform specification isobutane, regardless of the usual seasonal and plant upsets.

Small temperature gradient . . . The deisobutanizer differs from the other towers in the train principally because there is a much smaller temperature difference between the bottom and top. Because the tray-to-tray temperature differences are small it is difficult to maintain uniform specifications in the overhead product when controlling from the conventional temperature and pressure measuring mechanisms.

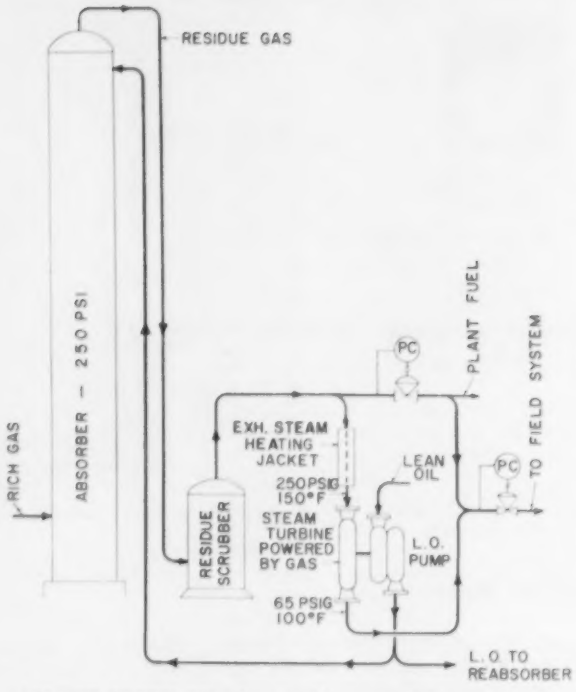
Fig. 10 shows a vapor-pressure fractionation controller known as a d.v.p. cell transmitter and Fig. 11 shows a typical installation on a tower. The transmitter operates in the same force-balance principle as shown in Fig. 9. It produces operable response to minute measurement changes.

Comparison method . . . In operating principle, if the bulb is filled with the same hydrocarbon as that in a selected tray, when the tower is producing the desired overhead product, the vapor pressure in the bulb system will balance the vapor pressure in the tray. If the composition in the selected tray changes its vapor pressure will not balance the vapor pressure in the bulb system.

The location of the selected tray is



POWER RECOVERY using hydraulic motor drive. Fig. 15.



POWER RECOVERY using a turbine powered by gas. Fig. 16.

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determined from the temperature gradient curve of the tower and the bulb system is filled from the tray after the unit is installed and the desired overhead product is being produced.

The pneumatic transmitter is adjusted to produce a 9-psi. output air pressure when the vapor pressure in the bulb system equals the vapor pressure in the tray. If the tray composition changes, its vapor pressure will change. The difference in vapor pressure between the bulb system and the tray will produce a change in output air pressure from the transmitter to a pneumatically operated control unit which may be adjusting the reflux rate, the tower pressure, or the reboiler heat input to restore the composition in the selected tray to its original condition.

Fig. 12 shows an actual chart from a deisobutanizer under vapor-pressure control, together with a chart showing the simultaneous pressure in the tower. For evaluating control performance, each minor graduation on the vapor pressure chart represents, in this case, 0.6 per cent actual change in the isobutane fraction. The other chart shows that tower pressure actually swung 10 psi. total, between midnight and noon. This variation was caused by the night-to-day variation in cooling-water temperature as the overhead condenser was an atmospheric section in the cooling tower base.

8. Boilaway Recorder

For spot checking fractionation efficiency the weathering or "boilaway" method is customarily employed. This consists of taking a sample from the product cooler, or reflux pump, inserting a glass thermometer into the sample in a glass graduate and logging the initial, middle, and end boiling temperatures. The quality of results obtained with this time-honored method can vary with the operator. No two individuals will read the divisions of a glass thermometer and glass graduate alike and furthermore the glass graduate becomes frosted over if the product composition is predominantly a lighter fraction.

In some gasoline plants this method has been supplanted by a standard single-pen, circular chart electronic recorder employing a bare resistance bulb as shown in Fig. 13. The high-speed balancing action of the electronic recorder, coupled with the high-speed response of the bare resistance bulb produces an indisputable and accurate record of boilaway temperatures.

Boilaway records . . . A series of typical boilaway temperatures of various products is shown in Fig. 14. The chart is graduated 100°-0°-100° F. In order that each shift may have its own chart records, the chart drive is 8 hours and each hourly interval represents 20 minutes. This chart indicates that high-purity propane, isobutane, and normal butane were being produced because the pen invariably left a sharp corner in the record as the last portion of boiling product exposed the bulb tip. Had there been heavy end contamination the record would have been distinctly rounded at this point as shown in the other two records which were samples of propane off the depropanizer reflux accumulator, contaminated with butanes.

After a few weeks' experience, the operators find that boilaway records prove a valuable tool in adjusting fractionator operation, and are responsible for reducing the number of regular Pod analyses which usually require a waiting period of 4 to 6 hours. For this reason the boilaway recorder is often mounted on the main control panel with the other instruments.

9. Rich-Oil Power Recovery

In the absorption section there is substantial pressure reduction in the rich-oil circuit, starting at the high-pressure absorber and proceeding through the successive stage flashes. Instead of dissipating all of this pressure drop across a control valve, there is a trend toward using some of this energy to drive pumps, cooling-tower fans, and other plant auxiliaries.

Hydraulic motor drive . . . Fig. 15 shows a power recovery system using a hydraulic motor. The rich oil from

the 750-psi. absorber flashes at 250 psi. To use the energy of a part of this pressure drop, a portion of the rich-oil stream from the absorber bypasses the level-control valve and passes through a hydraulic motor which drives the reabsorber lean-oil pump and the bypassed oil reenters the circuit downstream of the level-control valve.

Protective override . . . The rate of flow of reabsorber lean oil is controlled by a flow controller adjusting the flow of bypassed oil through the hydraulic motor. A protective override, in the form of a diaphragm-actuated air line vent valve is installed in the flow-controller air output line. Under normal operation the vent valve is held closed by the air pressure on the base level-control valve. However, if the absorber level falls to a predetermined low point, the level-controller output air pressure will drop to a minimum, the vent valve will open, the flow control valve will close, and the flow of rich oil through the hydraulic motor stops. A positive oil seal is always maintained in the absorber base preventing a high-pressure gas breakthrough to low-pressure equipment.

A 40-hp. installation was placed in operation in 1952. This plant has recorded an uninterrupted service run of 16 months and the success experienced with this early installation has led this particular company to make two additional installations of 40 hp. and 100 hp. each *(See The Oil and Gas Journal, January 2, 1956, page 80, and April 27, 1953, page 161).*

Check costs . . . It is economical to use hydraulic-motor drives rather than electric motors if the unit cost plus maintenance cost of the hydraulic unit is less than the initial cost of an electric motor plus its maintenance and operating power cost. Other applications for the hydraulic motor may be to generate a hydraulic pressure which can be piped to other parts of the plant to operate pumps, air-cooled fans, or other auxiliaries.

10. Absorber-Gas Power Recovery

Pressure drop in the high-pressure absorber residue scrubber outlet gas may be used as a source of operating power as shown in Fig. 16. The 250-psi. absorber residue was originally reduced to 65 psi. for the field system and plant fuel requirements and the lean-oil pump was stream-turbine driven.

Gas turbine . . . The installation was altered, as shown, to use the energy of the residue gas by expanding it through the turbine, in place of steam. As there is always more residue gas than required for pumping the lean oil, the single back-pressure controller, "PC" in the plant fuel line will maintain the absorber pressure.

A simple steam jacket at the gas inlet to the turbine will raise the gas temperature sufficiently to eliminate the hydrate formed by the temperature drop which accompanies the gas expansion. Plant exhaust steam, normally used for building-heating purposes, is used in the jacket.

The turbine in this operation is rated at 80 hp. and although it has remained crossconnected to steam, it has operated solely on gas since early 1949. Service life has been excellent. In that period only two shutdowns have been necessary, each for pump repairs.

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Here's How N.G.A.A. Absorber-Design Program Is Functioning

THE problems associated with evaluation of absorber design methods and the correlation of tower test data have concerned many plant designers and operators. Composed of engineers interested in these problems, the Absorption Subcommittee of the Technical Committee of the Natural Gasoline Association of America was organized with the objective of studying absorber test data.

Under Chairman M. F. Wirges, of Cities Service Oil Co., the work of the subcommittee has been divided into the following categories:

1. Compilation of absorber test data.
2. Investigation of the proper equilibrium ratios to be used in absorber design.
3. Evaluation of absorber mechanical design.
4. Preparation of a test procedure to be used in evaluating absorbers.

In the first category, the subcommittee has collected about 50 sets of absorber data, including tray and tower layouts from participating companies. In addition, E. G. Ragatz has made available to N.G.A.A. his summary of approximately 400 tests. These data are now being reviewed in a 1-year study at University of Michigan college of engineering under the supervision of Brymer Williams.

The ultimate objective of the subcommittee is the preparation of an absorber design and testing procedure manual. The first phase of the study which will be completed and reported by November 1956, at Michigan has as its objectives: (1) Evaluation of the collected test data using the recently issued N.G.A.A. vapor-liquid equilibrium data books and the best available enthalpy data; and (2) The establishment of a yardstick for measuring total absorber performance.

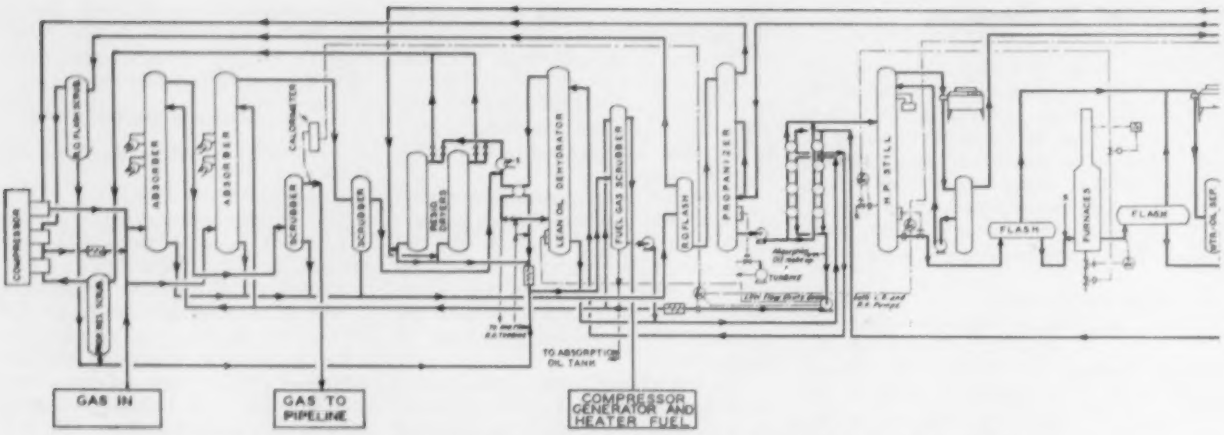
The appraisal of the various methods for process design and for tower-sizing methods which had previously been started by the subcommittee will be continued.

As the study continues, it is apparent that the assistance of other technical subcommittees, particularly the Fractional Analysis and the Equilibrium Ratio groups, will be needed in achieving the stated goal. The N.G.A.A. program will be closely coordinated with and supplement the objectives of the experimental program of the American Institute of Chemical Engineers.

The latter is a 5-year program ending in June 1957, devoted to the determination of the effect of geometric factors and physical properties upon individual tray efficiencies.

The programs of the N.G.A.A. and of the A.I.Ch.E. are an interesting method of cooperative, but coordinated efforts to attack and solve problems common to many industries. Since the work is at universities, one incidental but valuable result will be the education of young engineers in some of the problems of the natural gasoline industry.

—Brymer Williams
University of Michigan.



LEAN GAS is feed for Ambrose gasoline plant of Cities Service, as shown by this flow diagram. Fig. 1.

Cities Service Ambrose Gasoline Plant . . .

- Uses perforated trays—gets increased capacity.
- Operates on lean-gas stream.
- Has two-still system—saves recompression, fuel.

by John C. Reidel
Journal Staff

RECOVERY of natural-gas liquids from a lean-gas stream can present problems not usually encountered in the conventional field gasoline plant. Cities Service Oil Co.'s Ambrose gasoline plant near Blackwell in Kay County, Oklahoma, is an interesting example of gasoline-plant operation on lean gas. In this plant, approximately 1 gal. per M.c.f. of gasoline-plant products is extracted from a gas stream, averaging 170 M.M.c.f.d. in 1955.

The plant uses a high pressure-low pressure two-still system and a rich-oil stripping column to obtain optimum efficiency when processing lean gas. Fuel and recompression requirements are minimized by this process combination. A residue-gas heating-value limitation restricts hydrocarbon extraction to approximately 50 per cent propane and essentially all of the heavier hydrocarbons.

Feed gas . . . At this plant the gas stream processed is available at a pressure of 500 to 600 psi., is essentially at ground temperature, and has been dehydrated. The plant process utilizes oil absorption with steam stripping; hence the lean-oil stream contains water. Unless this water is removed from the oil, enough would be stripped out in the absorbers to require dehydration of the gas.

The Ambrose plant uses the plant fuel-gas stream to strip water from the oil, eliminating the necessity for additional gas dehydration. The process scheme adopted uses the fuel gas to drive a pump (by expanding through a turbine), then this gas is used to strip water from the lean oil, and then it is utilized for plant fuel.

The new process developments have performed satisfactorily. This was the first gasoline plant to use perforated-tray columns throughout the absorption, distillation, and fractionation system. Day-to-day plant operation and special process tests have shown that the perforated-tray columns can perform satisfactorily throughout a wide range of load conditions. The capacities believed possible with these trays have been verified.

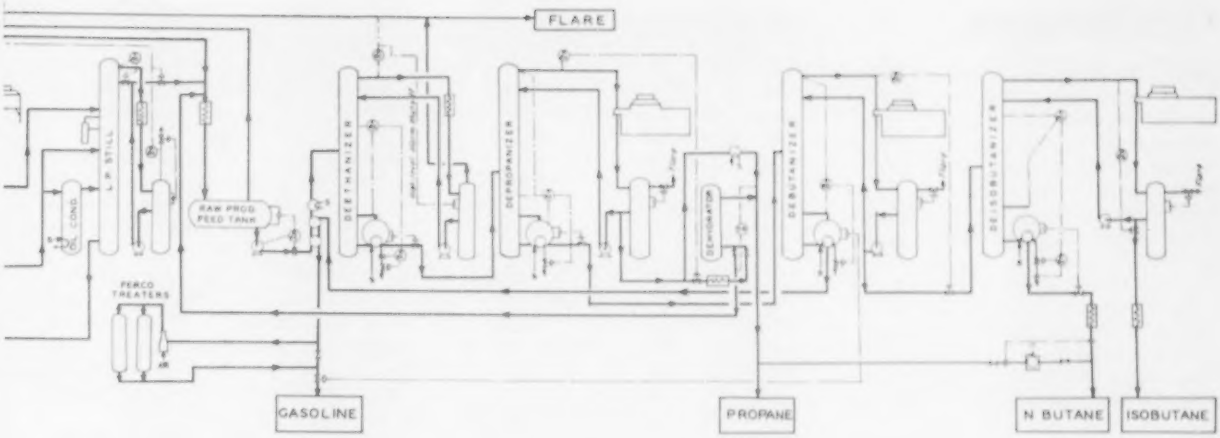
Cooling tower . . . Most of the aerial cooling requirements were combined with the induced-draft cooling-tower requirements in one unit. The air used to cool water is also utilized for aerial cooler services. This allows the aerial coolers to be designed on the basis of the maximum wet-bulb temperature anticipated, and since an appreciable amount of air can be bypassed around the bottom section when air temperatures are low, cooling-tower water requirements are reduced extensively.

In 1955, the plant processed approximately 170 M.M.c.f. of gas daily and produced 73,000 gal. of propane, 22,000 gal. of isobutane, 33,000 gal. of normal butane, and 43,000 gal. of natural gasoline. The plant is designed for an ultimate gas rate of 190 M.M.c.f. of gas and a daily production of approximately 250,000 gal. of natural-gas liquids.

Tray tests . . . Since this plant was the first to use perforated trays so extensively, Cities Service has done considerable additional testing to develop additional information on the capacity and effectiveness of these columns. Tables 1 and 2 summarize the results of a plant test with the plant processing approximately 218 M.M.c.f.d.

Additional tests have been completed on the absorbers, high-pressure still, and deisobutanizer. Tests on the absorbers have included operation with as much as 150 M.M.c.f.d. of gas and 750 g.p.m. of oil processed in one of the two absorbers.

Tests on the deisobutanizer have been made with the ratio of normal to isobutane in the feed varying from 2 to 3 and with reflux ratios varying from 10 to 20 to 1. Additional studies are being completed; however, work has not progressed to the point where summaries of this progress were



Field Processing

available for release by Cities Service Oil Co.

Process Scheme

Operation of the Ambrose gasoline-plant absorption, distillation, and fractionating sections is indicated in Fig. 1.

Absorption . . . The pressure on the gas stream to this plant varies between 500 and 600 psi. Two 24-tray absorbers, 8½ ft. in diameter, are used, each equipped with two intercoolers. Lean oil to the absorbers is supplied by steam-turbine-driven pumps, with oil flow regulated by recording flow controllers.

Lean oil contacts the gas in the absorbers by passing over the perforated trays. These trays are similar to bubble trays in that the oil passes across the tray, over an overflow weir, and into a downcomer. Gas passes up through the trays through ¼-in. holes which have been punched in 10-gage plate. Approximately 12,000 perforations per tray are utilized in these vessels.

Rich oil from the absorber flows to the rich-oil flash tank, where a considerable portion of the methane and ethane present is flashed. Operating at 300 psi., some 2½ to 3½ M.M.c.f. daily is flashed, goes to the recompressor, and is recycled to the absorber inlet.

Propanizer . . . Rich oil from the flash tank enters the top tray of the propanizer. This 12-plate, 10-ft. i.d. column, performs two functions. Uncondensed gas from the still overhead contains appreciable amounts of propane and heavier components. This uncondensed gas stream is used to strip methane from the rich oil. The high oil-to-gas ratio in this vessel allows high absorption of propane and heavier components with displacement of the methane.

The rich oil has about the same vapor pressure entering and leaving the propanizer; however, absorbed methane has been displaced without high loss of the propane and heavier components.

Operation of the column is simple and essentially automatic. If too much methane remains in the rich oil in the bottom of the column it will cause more uncondensed vapors to accumulate in the raw-products tank. These uncondensed vapors then pass back into the bottom of the propanizer and increase the stripping of methane. This, in turn, reduces the amount of methane passing into the raw-products tank. Thus, the column performs a function somewhat similar to a rich-oil demethanizer.

Two-still system . . . Rich oil from the base of the propanizer is pumped through the tube side of oil-to-oil exchangers to the high-pressure still. The rich-oil pump is driven by a gas turbine with electric-motor-driven pump as standby. The heat exchangers bring the rich-oil temperature up to about 450° F. The high-pressure still, 10 ft. in diameter, has 10 trays in the stripping section and 6 trays in the rectifying section and operates at approximately 200 psi.

The more volatile hydrocarbons in the rich oil are stripped in the high-pressure still. Enough products are removed so that when the remaining products are stripped from the oil in a low-pressure still, these products will be totally condensed. The hydrocarbons stripped from the high-pressure still are partially condensed by aerial coolers with the condensed portion used for reflux. After commingling with the raw products, the uncondensed vapors are separated and returned to the propanizer.

The partially stripped rich oil from the high-pressure still is flashed at

TABLE I—AMBROSE PLANT BALANCE
(Quantities given in moles per day except where noted)

Constituent	Gas in	Absorber residue gas	Rich oil from absorbers	R.O. flash tank gas	Propanizer residue gas	Oil to high-pressure still	Oil to low-pressure still	Deethanizer residue gas	Propane product	Natural gasoline product	Isobutane product	n-Butane product
CO_2	2,787	2,787	104	64	40	78						
N_2	66,144	66,144	458	343	115	155						
C_1	445,278	445,278	13,155	5,541	6,846	5,625		768				
C_2	30,735	30,563	7,226	719	1,224	10,636	1	5,111	172			
C_3	19,175	11,543	9,807	350	661	12,583	251	1,114	7,632		50	
iC_4	2,669	661	2,073	24	39	2,441	195	2	41		1,943	24
nC_4	5,592	171	5,591	45	93	6,149	680		59	967	10	4,385
iC_5	673		687	4	10	693	213			673		
nC_5	686		686			741	269			686		
C_6+	1,145		1,149	4		1,145	277			1,145		
Abs. oil			63,288			63,288	63,288					
Total moles per day	574,884	557,147	104,224	7,094	9,028			6,997	7,904	3,471	2,003	4,409
M.s.c.f.d.	217,882	211,273		2,688	3,422			2,652				

about 135 psi., the vapors are cooled by an aerial cooler, and used for part of the low-pressure still reflux. The rich oil from the flash tank goes through rich-oil furnaces rated at 29 M.M. B.t.u. per hour, is again flashed and then flows to the lower-pressure still at a temperature of approximately 560° F.

In the low-pressure still, an 8-ft. i.d. column operated at about 60 psi., the remainder of the absorbed hydrocarbons are stripped from the oil stream, condensed, and used for reflux with excess liquid flowing to the raw-product feed tank.

Lean-oil dehydrator . . . Lean oil from the low-pressure still at about 535° F. is reduced to 310° F. by exchanging with the rich oil to the high-pressure still. The lean oil enters the top tray of the lean-oil dehydrator, an 8-ft. i.d. vessel with eight trays, operating at approximately 35 psi. Plant fuel-gas stream is used to strip water from the lean oil.

The fuel gas is then cooled, liquids are removed, and this gas enters the fuel system. The dry lean oil from the base of the dehydrator is further exchanged with the rich oil to the high-pressure still and is then cooled by coils in the cooling tower prior to returning to the absorber.

Product fractionation . . . Combined top products from the two stills go through the raw-product condenser in the cooling tower water section, and the vapor-liquid mixture enters the raw-product feed tank operating at 200 psig.

Raw-product feed tank is sized to hold 4 hours' production. The raw-product tank is provided with a long-range liquid-level displacer and the liquid-level controller resets the flow-recording controller on the deethanizer feed. With this arrangement large fluctuations in feed rate to the deethanizer can be eliminated.

The fractionation section consists of a four-column train operating in conventional cascade arrangement.

Deethanizer . . . Raw product exchanges heat with debutanizer bottoms and is further heated in a steam-heated preheater before entering the deethanizer. This column operates at approximately 430 psig. and minimum reflux temperature is desired for maximum propane retention. Interconnected control is employed to maintain the deethanizer bottoms temperature.

Temperature of vapor in return line from reboiler is recorded by a temperature-recording controller. This instrument also resets the flow controller on steam condensate line from reboiler. The liquid level in the reflux accumulator controls the column reflux rate. Deethanizer pressure is controlled by pressure recording controller operating a valve in deethanizer residue gas line from reflux accumulator.

The residue gas goes through the deethanizer residue gas driers. These vessels contain a solid desiccant. The gas stream from the deethanizer then goes to the recompressor. Regeneration of the driers is with gas from the plant fuel line. This gas is passed through a steam-heated bundle and raised by 350-psig. steam to 400° F.

Depropanizer . . . The deethanizer bottom product drops in pressure from 485 to 300 psig. through the control valve regulating its flow from the reboiler. Operation of the depropanizer is conventional. A flow-recording controller regulates reflux rate.

Top-tray temperature is measured and recorded on the panel board. This record indicates quality of the propane taken overhead (a rise in this temperature indicates more isobutane coming over). A second thermometer bulb is located in the "knee" of the stripping section—between the feed plate and the reboiler.

A temperature-recording controller throttles reboiler steam condensate line according to the temperature measured by the second thermometer bulb. Its location is such as to allow the column to depropanize the feed while the reboiler temperature is permitted to vary.

The depropanizer overhead vapor goes through coils in the air-cooling section of the large cooling tower. Product goes through a small cooling section in cooling tower. Pressure on depropanizer is controlled by valve in the propane make line with the flooded condenser-bundle principle used to control depropanizer pressure. Increased pressure opens the control valve more, draws level down in condenser, exposing more tubes, and leading to faster condensation and reduction in pressure.

Propane product is passed through the propane dehydrators which operate just like the deethanizer residue gas driers, except that regeneration is with propane superheated to 400° F.

Debutanizer . . . Depropanized bottoms pressure into the debutanizer which operates at 80 psig. This column makes grade natural gasoline from bottom and mixed butanes from top. Stripping section consists of 10 trays and rectifying section of 20 trays. Top-tray temperature record indicates butane quality. In the case of the debutanizer, reboiler temperature is set for a given grade of gasoline. The controller then holds this temperature to make a constant-vapor-pressure bottom product.

The gasoline product exchanges heat with deethanizer feed, then goes through a Perco heater to remove mercaptans.

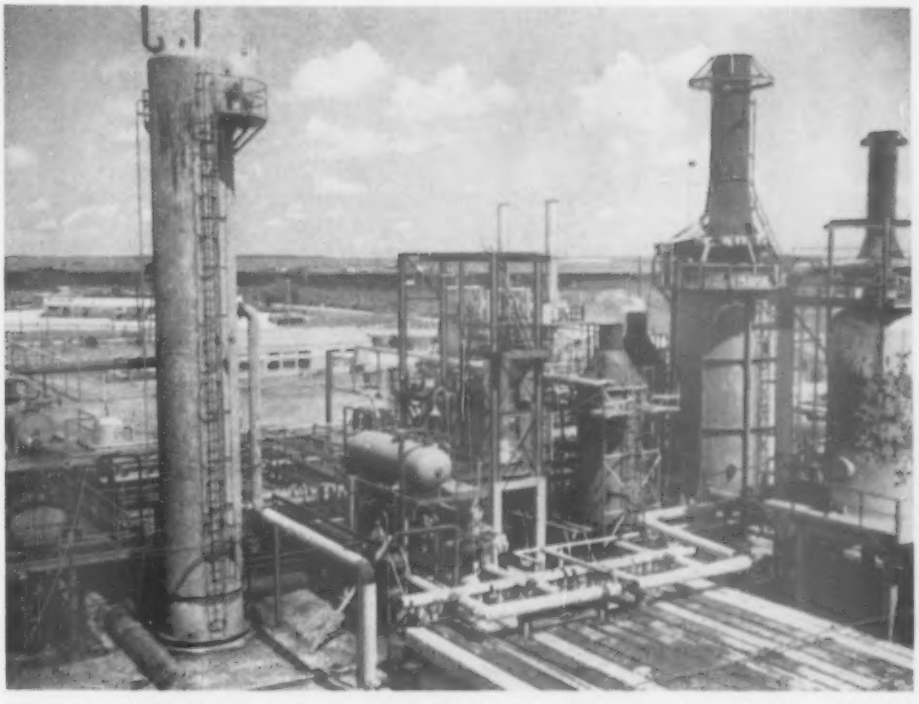
Deisobutanizer . . . The butane splitter operates at 120 psig. and produces 95 per cent purity iso and normal butane products. This column has 28 trays in the stripping section and 32 in the rectifying section. This is a comparatively difficult separation, with an average of only about ⅓° F. temperature gradient per tray. Reboiler temperature is recorded but not controlled. Control temperature is in the "knee" of the rectifying section.

If this temperature should change, due to change in rate of feed or reflux, the temperature controller will automatically change the set point of a flow-recording instrument which will change the steam rate through the reboiler.

TABLE 2—COLUMN OPERATING DATA

Absorbers (Two)	
Pressure, psig.	550
Residue gas, °F.	80
Rich oil, °F.	75
Number trays	24
Intercoolers—not operating.	
Column diameter, in.	8 ⅛
High-Pressure Still	
Pressure, psig.	200
Top temperature, °F.	191
Oil in, °F.	450
Oil out, °F.	447
Number trays	16
Steam, lb. per hour	7,810
Column diameter, ft.	10
Reflux ratio	1.08
Low-Pressure Still	
Pressure, psig.	62
Top temperature, °F.	196
Oil in, °F.	557
Oil out, °F.	534
Number trays	24
Steam, lb. per hour	2,655
Column diameter, ft.	8
Reflux ratio	2.1
Deethanizer	
Pressure, psig.	430
Reflux temperature, °F.	74
Reflux ratio	1.80
Number trays	30
Column diameter, ft.	5
Depropanizer	
Pressure, psig.	302
Reflux ratio	3.46
Number trays	36
Column diameter, ft.	5½
Debutanizer	
Pressure, psig.	78
Reflux ratio	1.47
Number trays	30
Column diameter, ft.	4½
Deisobutanizer	
Pressure, psig.	117
Reflux ratio	14.1
Number trays	60
Column diameter, ft.	5½

Reflux ratio is given as moles reflux/moles product.



TEXAS GAS CORP. operates this Platformer at its Winnie, Tex., plant, to make a high-octane motor-fuel component. About 2,100 bbl. per day of distillate naphtha is catalytically reformed.

With two alternatives for markets, for natural-gasoline manufacturers it's

A TIME FOR DECISION

Field processors must fractionate and convert their raw product to realize greatest potential returns—or defer to others and share future profits. Transportation costs must be reduced.

by George Weber

NATURAL gasoline is assuming a new role in the petroleum and chemical industries. From its traditional usage as a straight blending component in motor fuel, this valuable fraction of light hydrocarbons will gradually widen its horizon, serving both refiners and chemical manufacturers in new ways.

This does not necessarily mean that the product as it is known today is going to command a higher price, at least in the near future. The promised end uses will entail separation and conversion of light hydrocarbons, requiring new capital investment and mounting costs of operation. New concepts in its preparation for future markets, and in its economical movement to them are called for, if this important product is to find its rightful place in tomorrow's technology.

A time for decision . . . Natural-gasoline manufacturers must now decide on how they wish to participate in this future market for their products. They have two alternatives. They can continue to sell their raw natural to buyers, taking what prices the market will bear. Or, they can individually or jointly invest in the necessary fractionation and processing facilities which will bring them a higher price for specialty products going to motor fuel and chemicals.

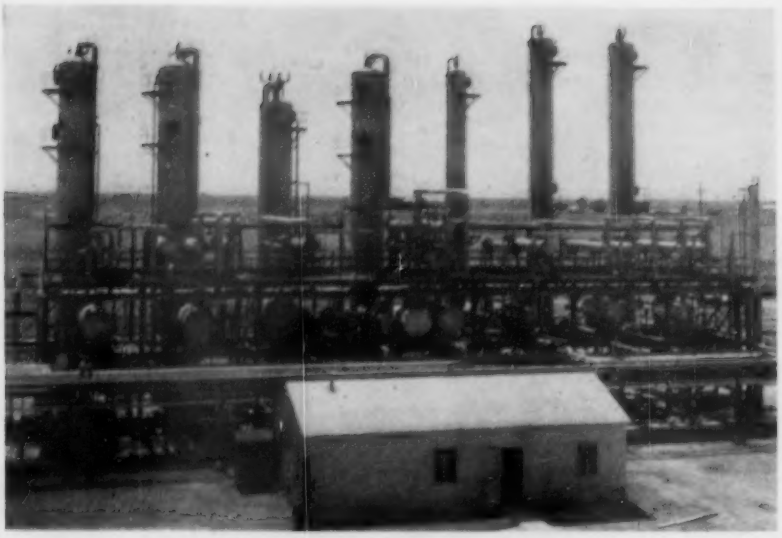
It is fairly evident that much natural in the future will be pooled either by refiners or other processors, for separation and processing an a large, economic scale.

Two forces are moving natural gasoline into new directions. The more immediate one concerns the declining importance of unprocessed natural motor fuel. This traditional outlet is threatened by the mounting octane levels of gasoline, and straight natural gasoline mixtures are being left behind by the octane race. They are still blended, but the benefits of volatility balance are no longer accompanied by the octane improvement formerly realized.

Competition is rising from crude sources too. Refiners are processing at higher levels of conversion in making gasoline today. These relatively severe operations produce more light ends which tend to reduce outside needs for low-boiling hydrocarbons.

A second, long-range factor promises natural gasoline including L.P.G. and so-called condensate or cycle product a firm place in supplying the basic materials not only for gasoline manufacture but for chemical synthesis as well. It is likely that field processors 10 years from now will command an excellent market for their output. But it will require separation, conversion, and efficient transportation.

Trend not established . . . The full impact of octane levels on natural-gasoline



ABSORPTION UNIT at Texas Gas Corp.'s Winnie plant. This unit is part of the processing setup which enables the company to market a finished motor fuel.

Field Processing

blending has not yet been felt. A review of this situation fails to show any trend through 1955. Table 1 shows the volumes of natural gasoline blended to motor fuel since 1935, and the fraction of finished gasoline represented by natural. These Bureau of Mines figures do not include butane shipped with natural for 1935-1940. Butane is included since 1941. This change in basis accounts for most of the increase from 1940 to 1942 and 1943. Since the war, however, refiners have upped their usage of natural gasoline plus butane from about 8.5 to 9.5 per cent.

How much longer this level of blending straight natural gasoline will hold is problematical. However, it is expected to taper off sharply. But the contribution of light hydrocarbons to gasoline should show no marked decline in the long run since a number of avenues remain to prepare these fractions for a place in the higher octane motor fuels of the future.

Composition important . . . In assessing the future of natural gasoline, it is well to take a close look at the product. Today, natural comprises several pure hydrocarbons in varying proportions. The content will vary with the sources of casing-head and dry gas processed in the field. The composition of a typical sample of 26-70 natural gasoline today looks something like this:

Isobutane	7
Normal butane	25
Isopentanes	15
Normal pentane	20
Isohexanes	9
Normal hexane	9
Isoheptanes	7
Normal heptane	4
Octanes plus	4

To round out the picture, distillate obtained from recycling high-pressure gas reservoirs must also be considered. These heavier fractions represent less than 20 per cent of the total natural-gasoline production in conventional field plants. But the product of recycling plants includes more of the heavier fractions which are of interest to many prospective processors today.

The following compositions of five debutanized distillates illustrates the variation in content:

	Examples				
	A	B	C	D	E
Isopentane	10	7	11.5	12	10
Normal pentane	6	5	18.5	10	12
Hexanes plus	84	88	70.0	78	78

Roughly 25 per cent of the hexanes and heavier fraction is represented by hexanes, the remainder comprising heptanes, octanes and heavier paraffins as well as some naphthenes and aromatics.

TABLE 1 — NATURAL GASOLINE'S SHARE IN MOTOR-FUEL PICTURE
(M. barrels for year)

Year	Natural blended	Total gasoline produced	Per cent natural
1935	31,025	457,842	6.8
1936	33,817	504,811	6.7
1937	39,381	559,141	7.0
1938	39,961	556,012	7.2
1939	39,606	596,501	6.6
1940	39,547	597,375	6.6
1941	47,825	671,110	7.1
1942	56,595	585,971	9.7
1943	61,198	592,425	10.3
1944	67,207	722,718	9.3
1945	70,324	774,460	9.1
1946	62,861	748,411	8.4
1947	70,692	814,841	8.7
1948	76,237	895,986	8.5
1949	85,457	939,051	9.1
1950	94,639	998,093	9.5
1951	99,250	1,108,880	9.0
1952	103,898	1,155,916	9.0
1953	111,293	1,233,954	9.0
1954	117,549	1,233,088	9.5
1955	126,382	1,330,863	9.5

Fractionation needed . . . With this general picture on composition, the means necessary to provide a place for these hydrocarbons in future gasoline are fairly obvious. Refiners will immediately recognize certain fractions as being readily admissible to gasoline as such, if they were separated out. Chief among these are the isopentanes which show blending values on the order of 106 research octane number leaded, which combined with catalytic base stocks in gasoline.

The isohexanes are also desirable. Some commercial isomers rich in dimethyl butanes will rate 104 research octane on the same basis. Refiners, of course, recognize the value of isobutanes as alkylation charge stocks and the current upswing in alkylation to produce higher motor fuel octanes should strengthen the market for this fraction, provided it is available in a high-purity form at refineries.

The first indication of what needs to be done to natural gasoline and cycle product then is fractionation. Precise fractionation is already paying off in some large-scale plants in the field and the need exists for extending this procedure.

But at this point the economics of fractionation raises obstacles to successful practice of this obvious first step. It is still not clear whether this step will be logical in the field. Probably separation of these desired fractions will be done largely in existing refineries, where the processing of the lower-quality remaining fractions can take place more economically.

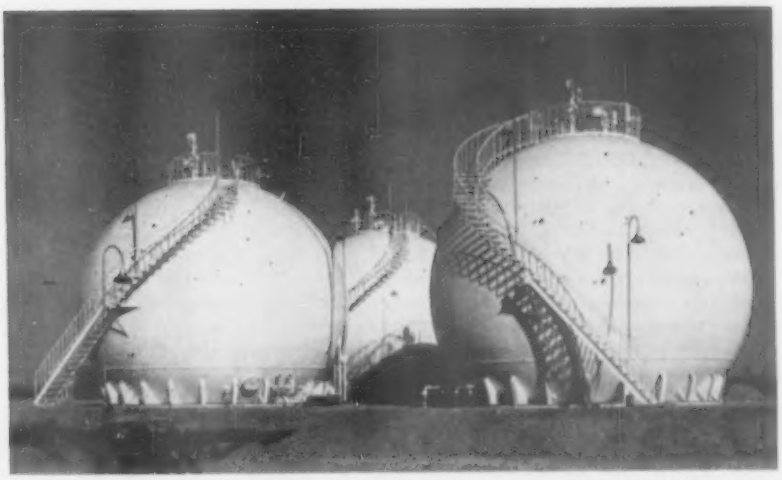
Processing Possibilities

Any consideration of upgrading products from field processing plants by separation of the desirable components naturally includes the problem of what to do with the remainder.

Here is where processing comes into the picture. There are available today numerous versions of catalytic reforming, isomerization, dehydrogenation, and alkylation which will undoubtedly find wide application in this field over the next several years.

Catalytic reforming . . . First, a look at catalytic reforming. There are at present four Platforming units either operating or under construction in field processing plants. They include: two at Atlas Processing Co., Shreveport, La.; and one each at Texas Gas Corp. at Winnie, Tex., Southwest Gas Producing Co. at Dubach, La., and Arkansas Fuel Oil Corp. at Panola, Tex.

Atlas, while not a field processing



BUTANE STORAGE FACILITIES for the Perkins plant of Texas Natural Gasoline Corp., Coke County, Texas. Combined liquid capacity of the plant is 300,000 gal. per day. (Photograph courtesy Chicago Bridge & Iron Co.)

Field Processing

plant, is a revamped refinery which charges distillate from plants located primarily in nearby Carthage field. This company installed one of the first Platformers and pioneered in the catalytic reforming of field distillate. Last year a second Platformer was added. Raw charge to the 17,500-bbl. per day plant is a mixture of natural gasoline and cycle product.

Total Platforming capacity now stands at 8,000 bbl. per day. The total charge is extracted to produce 650 bbl. per day of benzene occurring in its natural form. The remainder is processed in the Platformer and a thermal reformer to produce motor fuel which is sold to marketers.

Texas Gas Corp.[1] is charging a 55.7° A.P.I. gravity field distillate with a 392° F. end point to upgrade pool octane of the plant from 86.5 to 93.5 research octanes with 3 ml. TEL. The charge comprises 54 per cent paraffin, 36 per cent naphthenes, and 10 per cent aromatics. None of this feed derives from crude distillation. The company plans to purchase more outside distillate and is considering the modification of the unit to a Rexformer.

Southwest[2] processes the production from multiple reservoirs in six nearby gas-condensate fields. The feed consists of 63 per cent paraffins, 16 per cent naphthenes and 21 per cent aromatics. The aromatics fraction is predominantly benzene, and this lighter fraction is fractionated out for reblending with the heavier hydrocarbons after they have been Platformed. The operation converts feed stock with a research octane clear rating of 48 to a finished debutanized gasoline showing research octane number ratings of 83.2 clear and 94.6 with 3 ml. TEL.

Arkansas Fuel Oil[3] will use its new 900-bbl. per day Platformer in Carthage field to upgrade its present gasoline production from 82 to 98 research octane number with 3 ml. TEL. This installation will include a feed-preparation section which will separate isopentane from the Platformer charge stream comprising normal pentane and heavier. The company will sell the isopentane for blending to avgas and motor fuel, and will market its remaining plant production as regular grade gasoline in the Shreveport area.

Reforming limitations . . . In a number of other instances, refiners have charged some natural gasoline and cycle product to catalytic reformers. One licensor of the Catforming process utilizes this type of feed both as a blend with crude naphthas and straight, on a blocked-out operation. In addition, some operators processing gas-condensate liquids are considering the installation of catalytic reforming. One example is the Katy plant in the Texas Gulf Coast. A catalytic reformer is planned for this plant, operated by Humble Oil & Refining Co. In some other localities, there exists enough cycle product to justify the installation of catalytic reforming.

The possibility of catalytically reforming natural gasoline was recognized early.[4] Cyclization and aromatization of the straight-chain hexanes and heavier takes place in the reforming process to produce high octane benzene, toluene, and other aromatics. In addition, the concept of extracting low octane components from reformate and recycling them for further processing.[5]

By and large, however, catalytic reforming is not going to provide the full answer for the natural-gasoline producer. Cyclization of hexanes and heavier takes place on a limited scale. Even then, aromatization of hexane gives a poor volumetric yield.

The benzene product is not a clean-burning component in gasoline and its octane rating does not contribute as much as it did in the earlier days of cat reforming. In order to realize the full benefits of this process, charge stocks should comprise mainly the C_7 and heavier fractions including naphthenes which will dehydrogenate to make prime motor-fuel blends. These heavier components are not present in sufficient quantity in natural gasoline, and the producer will have to look at additional processing.

Isomerization looms big . . . The process which best suits their needs for the present is pentane and hexane isomerization. Coupled with efficient fractionation for feed preparation and extraction of recycle streams, this process will permit a sharp improvement in octane quality of total gasoline product—at a price.

The operator now has three commercial processes to consider, and several more are in the offing. The Isomate process[6] was used commercially during World War II to produce high-octane stocks for avgas blending. Licensed by Standard Oil Co. (Ind.) it is now being adapted to present-day requirements for isomerizing normal hexane or pentane-hexane mixtures.

This process can be employed on a once-through or recycling basis. Recycle product charging hexane shows a leaded octane rating equivalent to isooctane plus 1.05 ml. TEL.

Another established process which may be considered is Shell Development Co.'s liquid-phase isomerization[7] process. This type of unit will convert either normal butane or normal pentane to the corresponding isomer.

A third process now available is Atlantic Refining Co.'s new Pentafining[8] process. Pentafining of the normal pentane fraction of natural gasoline, coupled with low pressure Catforming of the C_6 and heavier fraction will convert 12-lb. R.v.p. natural gasoline to a leaded 100-octane product.

On the way are at least four more processes which will be designed specifically to isomerize pentanes and hexanes from natural gasoline, cycle product, and crude naphtha fractions. Most of these should be introduced within the next year. The close attention now being paid to isomerization in research laboratories promises to provide the natural-gasoline manufacturer and refiner with new tools for upgrading low octane normal paraffin to high quality isomers.

Isomerization of the C_5 and C_6 fractions either separately or in a mixture

appears to be well developed. The C_7 paraffins now comprise a major problem. There is now some promise that heptane isomerization will become economically possible. Until recently, it posed a problem, but one company will shortly reveal successful laboratory results in converting this hydrocarbon to a branched chain form in mixture with lighter fractions. Whether this will reach successful commercial application remains to be seen.

Further down the line is the possibility of other processes or process combinations which may treat the whole natural gasoline fraction as charge stock. This will entail isomerization of C_5 and C_6 straight-chain paraffins and cyclization and aromatization of C_6 and heavier in one pass of a mixed feed stock.

At least one major development company is working on this problem, and the evolution of a technique for upgrading raw natural to finished gasoline is at least a possibility in the future.

Isomerization in reformers . . . In addition to these processes designed expressly for isomerization, some conversion of this type takes place in catalytic reformers. Licensors of both Platforming and Catforming processes have reported that isomerization of C_6 and other fractions occurs in normal catalytic reforming operations. One processor, using a conventional catalytic reformer, has successfully isomerized a normal pentane, obtaining a 50 per cent yield of isopentane on a once-through basis.

Since the equilibrium on isomerization limits isomer yields to 55-60 per cent on a once-through basis, the operator considering such a process should plan to split his product and recycle the normal paraffins. Recycling normal pentane to extinction would normally double the size of the splitter. Hence, fractionation equipment will represent roughly 80 to 90 per cent of the total cost of an isomerization unit if the operator intends to go all the way in obtaining isomer yields.

Specialized units providing for recycling all normal pentanes to extinction can be built for $100 to $400 per barrel per day capacity, depending on the amount of fractionation equipment required.

Operating costs are estimated to range variously at less than ½ cent per gallon of product. This is considered well within the realm of economic possibility if the operator has a charge stock with an isopentane-normal pentane ratio of 3 to 2 or even 1 to 1. The ratio of isopentane to normal pentane in natural gasoline ranges generally from 40 to 60 to 60 to 40. On the average, it runs close to 1 to 1.

Other processes . . . While it is improbable that the average field processor will find it currently feasible, alkylation and dehydrogenation offer further means for upgrading his product. In many refineries, extraneous isobutane is being used to balance the butylenes available for alkylation. Some natural-gasoline producers are today splitting out isobutane for sale to refiners and the possibility of isomerizing normal butanes for outside markets should be considered in some cases as a means for upgrading natural gasoline plant production.

Many producers declare that isobutane is their only product commanding a good price today. There is a plentiful supply available, needing only separation. A possible competitor to the producer is the chemical manufacturer who may buy mixed butanes and do his own splitting, using normal butane in his operation and selling the isomer on the open market. This is contemplated in some new butadiene operations.

One field processing company, El Paso Natural Gas Co.,[9] is moving fast on a plan to incorporate its natural-gasoline facilities with those of three small refineries recently purchased in the Permian and San Juan basins of West Texas and New Mexico. A new pipeline will be laid from Midland County, Texas, to El Paso to handle an alkylation plant which will produce high-octane blend stocks for blending to refinery gasoline made at Brickland, N. M.

Later, the output of two additional refineries at Bloomfield and Prewitt in the San Juan basin may be tied into the system. El Paso is building a butadiene plant at Odessa, Tex., jointly with General Tire & Rubber Co. The new plant, employing a Houdry process for dehydrogenating butane and butylenes and butadiene, may provide butylene for the alkylation operation.

Natural-gasoline producers with supplies of isobutane may in the future consider using the dehydrogenation process to supply needed butylenes. In fact, a major licensor of this process is now working on a modified version which will make butylenes only, at a considerably lower figure on capital and operating costs. Normally, the butane dehydrogenation process can be employed to make both products in various desired ratios. This type of operation is planned by Texas Butadiene & Chemical Corp. which will produce both that product for synthetic rubber manufacture, and butyene alkylate for aviation gasoline contracts in the Gulf Coast.

L.P.G. . . . The poor outlook for natural gasoline as a gasoline blending stock does not hold for butane. It is probable that butane blending will decline little if at all over the near future. A recent survey of gasoline marketed in four major U. S. cities indicated that refiners could boost R.v.p. by 1¼ to 1½ lb. with more butane, without risking vapor-lock troubles.

Over the next several years, however, if pentane isomerization catches on, refiners may be tempted to blend higher fractions of this high-octane fraction to gasoline. This may cut into the butane market to some extent. But refiners are being warned against use of too much pentane to obtain front-end volatility, since this practice is likely to contribute to vapor-lock troubles.

For the extended future, the place of butane in motor fuel is in question. It appears probable that long before the gas turbine appears on the scene in major numbers engine designers will have adopted fuel injection to improve the efficiency of the piston engine.

Just what effect fuel injection will have on the gasoline distillation curve is right now a subject for disagreement. Studies conducted by the DuPont company last year[10] lead them to predict that once all cars on the road are equipped with fuel injection, the refiner will be able to market gasoline with a higher volatility. But another side of the picture was presented last month by the Ford Motor Co.[11] Future gasolines, fuel injection notwithstanding, will be more critical on volatility, according to a Ford spokesman, and the refiner will be strictly limited in the light ends he will be able to blend to gasoline.

It is entirely possible that by the time these future factors come into play, the natural-gasoline manufacturer will enjoy a growing market for his butanes in the petrochemical field and gasoline blending may not assume the importance it holds today. Enthusiasts on petrochemicals sometimes lose sight of the fact that even today, this class of chemicals absorbs a very small fraction of total petroleum and natural gas output. It is estimated that 8 per cent of natural gas now goes into petrochemical manufacture. L.P.G. enjoys a larger market, moving roughly 30 per cent[12] to chemical and rubber companies for conversion.

The proportion of natural-gasoline components heavier than butanes is much less, probably less than 1 per cent. The future projection for petrochemicals gives the largest share of increase to butane and it is likely that the industry will find the heavier natural gasoline fractions harder to move than L.P.G.

With a strong growth curve for bot-

tled gas usage, propane does not appear to present any future problem. As the L.P.G. fuel market expands and moves more and more to favor of propane, field processors will expand their propane recovery systems. Petrochemical demand for propane will also tend upward, according to the experts.

In addition to the conventional chemicals now derived from propylene, a new class of olefin polymers similar to polyethylene is believed to show vast promise in the field of plastics. The emphasis in this new work seems to be on propylene polymers although it could also include those derived from butylenes.

Natural gasoline to chemicals . . . For the present, the petrochemical outlet for the pentane and heavier fractions in natural gasoline is limited. This does not mean that the market cannot grow considerably. But for high-volume outlets, the natural gasoline producer must still consider the refiner as his primary customer. Actually, as octanes continue upward, those products of natural gasoline which will find a place in motor fuel will actually be petrochemicals. They will comprise natural isomers and converted fractions which may well attract the interest of chemical manufacturers as charge stocks.

Precise fractionation of the natural-gasoline fraction will place the manufacturer in a position to supply an increasing demand for pure light hydrocarbons. It is possible that their reforming may provide a new field for chemical manufacture now unknown. Certainly, cyclization and aromatization of these heavier fractions will open the field of benzene, toluene, xylenes, and other aromatics to the natural-gasoline industry.

Logistics a Major Factor

For the average natural-gasoline producer, this talk of separation and processing may sound entirely impractical. It is true that the costs involved in processing natural gasoline in the small quantities found in most plants would be prohibitive, at least for the present. But ideas in the natural gasoline field are being reoriented and more companies are looking into the possibility of engaging in processing on their own, or in combination with others.

They may take a tip from the small refiners who have made a success of small-volume operations which would have looked impractical if the refiner had remained biased in favor of the larger-scale operations which are characteristic of gasoline or distillate-fuel manufacturer.

Independent producers in many areas such as Houston, Corpus Christi, Carthage, West Texas, East Texas, South Louisiana, and Los Angeles County may consider joint operations, pooling raw material production for more economic fractionation and processing. There are, admittedly, legal hurdles to this concept. Care should also be taken not to tie output to a single market which might go elsewhere for raw materials.

In such a setup, there may be a place for a third party which would consolidate the production of several natural-gasoline plants, and fractionate or process the material for long-term contracts. A likely location for such an operation would be at the terminus of a pipeline handling natural gasoline exclusively, or in tenders along with crude oil.

Possibly the industry will defer to refiners and chemical manufacturers and settle for a fraction of the income to be realized from light hydrocarbons in the future. Under such an arrangement, the field processor may find that his output will continue to move under a fairly low price ceiling unless he can deliver it to the user more economically.

Many refiners are becoming interested in using more natural gasoline and cycle product in their operations—at a price. They produce similar hydrocarbons in their own operations, but could make room for more if they were available at a cost competitive to that of the crude-derived light ends. But in many cases, these potential charge stocks when delivered in the conventional tank cars, are too costly to compete, and refiners will augment their needs by running more crude to stills.

Hence the natural-gasoline manufacturer is going to find the cost of transportation looming ever more important in his profit picture. In this respect, pipeline and even barge and tanker movement should be seriously considered. Many major companies are today using pipelines to move natural gasoline and L.P.G. to refineries and markets at a fraction of the cost by rail. Pipeline companies need to be sold on the feasibility of handling natural gasoline along with crude oil.

Specialty lines . . . At the present time, pipeline systems for exclusive handling of natural gasoline and L.P.G. are getting a lot of attention. Such lines are now moving light ends from East Texas to Houston, from West Texas to Beaumont, and from various outlying Gulf Coast fields to refineries on tidewater. Others are proposed from the Permian basin to El Paso, South Texas to Houston, and from Alberta to Winnepeg in Canada.

But pipeline systems need not be converted to full-time handling of natural gasoline or L.P.G., as the light products can efficiently be handled as tenders in crude lines. For example, natural gasoline is being moved effectively from the Lower Rio Grande Valley to Corpus Christi in tenders between crude shipments. The light product is given separate storage at the terminus and is being moved to the East Coast by tanker as refinery charging stock. This is no longer an unusual practice.

Natural gasoline is also being blended directly with crude in pipelines, and this practice is spreading. Substantial volumes of natural are now being moved long distances with crude. Despite some reluctance on the part of pipeline operators to consider this light product, the vapor pressure of the natural-crude mixture does not present any important problems if the stocks are correctly blended.

Barge and tanker movements should come up for more consideration in the future. There is a definite need for new thinking on natural gasoline transportation if producers are to maintain their present price level.

Underground storage offers another means to higher returns. Refiners are adopting this practice at plant sites for low cost storage of intermediate streams and finished product. Similar storage capacity at field processing plants or preferably nearer markets should be worth investigation in many instances.

The natural-gasoline manufacturer is today confronted with the need to make a choice on his role as a future supplier of light hydrocarbons. He may elect to enter into separation and processing on his own or jointly with others, and increase his future realization at a higher capital investment and operating cost level. Or, he may choose to sell his raw product for what he can get, to refiners or other processors who will assume the further refining which will be necessary before it can be used in fuels and chemicals.

Separation and conversion is definitely necessary in the future. With either alternative, the field processor of raw gas must investigate more economic means of transportation in order to realize a maximum return on his liquid product.

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Vapor-Velocity Effects On Bottom-Entry Trays

by E. G. Ragatz and H. A. Baxter

The authors found that . . .

Entering jet velocities play little or no part in the establishment of column tray efficiencies in high-capacity columns. The dominating tray-efficiency factor as far as vapor loading is concerned is turbulence. Specifically, it is the degree of over-all contact-zone turbulence developed by the average velocity of the vapors as they flow upward through the main body of the tray contact zone.

"BOTTOM-ENTRY" column trays are receiving increasing attention from design engineers for their demonstrated capacity superiority over conventional bubble-cap trays.

These are perforated-plate and similar type trays which introduce the upflowing vapor stream into the lowest plane of the tray's vapor-liquid contact zone with a minimum change of direction.

Also, various investigators[1 2 3] have shown that even simple perforated-plate trays can be designed to compare favorably with the majority of bubble-cap trays in efficiency. However, extensive testing of various types of both bottom-entry and bubble-cap trays over a wide range of absorption services has demonstrated that the efficiency of all such trays increases significantly with increased tray-loading.

This clearly indicates the possibility of significantly improving on the majority of current absorption operations. This improvement potential poses a basic question for the bottom-entry tray designer:

Is the higher efficiency exhibited by the heavier loaded tray due primarily to higher gas inlet-jet velocities, or rather to the associated higher gas velocities attained within the main body of the gas-liquid contact zone?

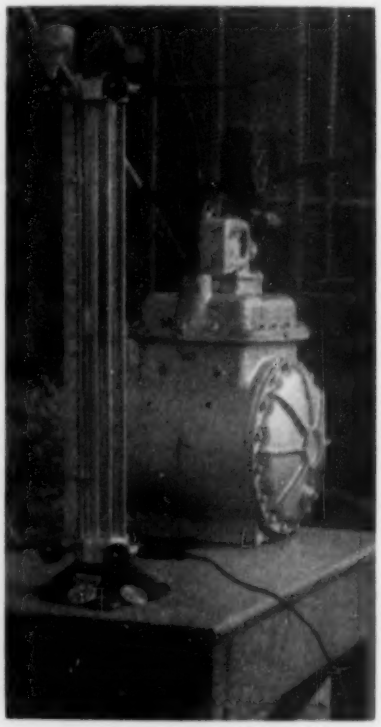
Aeration Tests

Looking to a physical-character indication of the answer to this question, a large number of aeration tests were run on three different absorption oils. Pressures ranged up to 200 psig., and a 0.611-sp. gr. absorber discharge gas was used for aeration. The three test oils were selected to cover a substantial spread in both molecular weight and characterization factor. Physical data on these oils are presented in Table 1.

The tests were run in a 24-in.-high, 1½-in. i.d. plastic aeration tube. Both simple and valve-type test plates, provided with commercial-sized gas-inlet orifices, were used. Gas rates varied from extremely low to very high, on the order of those attained by the best of currently operating commercial trays.

Fig. 1 presents a photograph of the assembled test apparatus, together with three of the bottom-entry test plates. The aeration tube proper consisted of a simple modification of a standard 1.5-in. i.d. commercial pressure hydrometer—lengthened to provide 24 in. of clear tube height. It was equipped with appropriate gas and oil inlet and outlet connections, and arranged for ready changing of the test plates.

A standard displacement meter of 15 cu. ft. per minute maximum capacity and 100 psig. maximum operating pressure was used to measure the rate of gas flow.



ASSEMBLED TEST APPARATUS and three of the tested bottom-entry trays. Fig. 1.

Test plates . . . Three simple perforated-plate disks equipped with 17 holes of 6/64, 8/64, and 10/64 in. i.d., respectively, were employed in the tests. One "valve" plate, equipped with seven Campbell rivets, was also used. The holes in the Campbell rivet plate were ⅞ in. i.d., while the rivet shank was ⅞ in. o.d. The head of the rivet was slightly truncated and equipped with three equally spaced bosses ⅛ in. wide by 1/32 in. thick.

With this construction, each seated rivet (and at no time did any rivet detectably leave its seat) developed three separate "ribbon" inlet-gas streams 0.265 by 0.03125 in. in cross-section. Area dimensions of the test-plate orifices are given in Table 2.

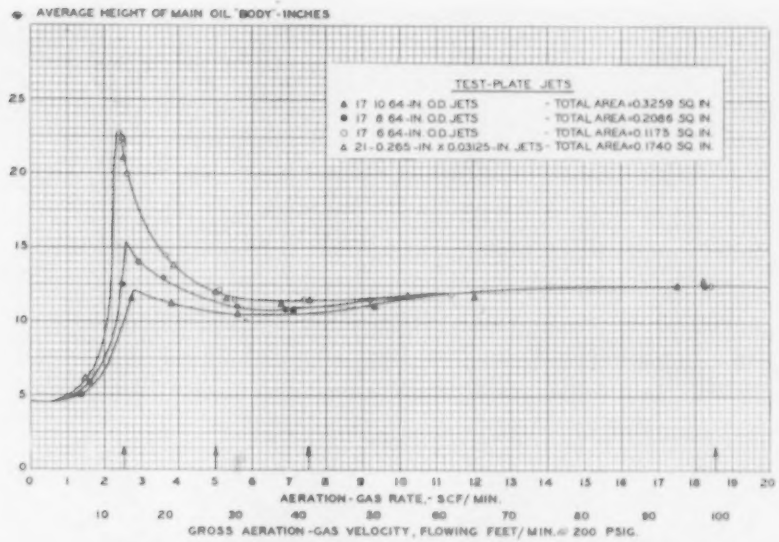
Many different combinations of oils and plates were tested at pressures of 50, 100, and 200 psig. The majority of the tests were run with an initial oil charge of 150 cc. Some of the oil charge was trapped beneath the test plate and some lost by mist carryover during the test run. At the same time some of the lean-gas fractions were absorbed.

Thus the height of the coalesced sat-

TABLE 1—LEAN-OIL PHYSICAL TESTS

Mol. weight	159	185	208
Gravity, °A.P.I.	40.2	38.1	38.1
"K"	11.57	11.67	11.84
C.N.G.A. Engler dist.:			
I.b.p.	330	340	370
5 per cent	360	430	470
10 per cent	367	436	485
20 per cent	381	443	500
30 per cent	388	450	503
40 per cent	394	456	506
50 per cent	400	461	510
60 per cent	408	471	513
70 per cent	420	480	517
80 per cent	437	491	524
90 per cent	470	509	534
F.b.p.	564	546	586
Recov.	98.9	98.7	98.8
Btms.	0.8	1.3	0.9
Loss	0.3	0.0	0.3

Authors are manager and chief engineer, respectively, Edw. G. Ragatz Co., San Marino, Calif.


AVERAGE HEIGHT OF MAIN OIL "BODY"-INCHES
TEST-PLATE JETS
▲ 17 10 64-IN O.D. JETS - TOTAL AREA=0.3259 SQ IN
● 17 8 64-IN O.D. JETS - TOTAL AREA=0.2086 SQ IN
○ 17 6 64-IN O.D. JETS - TOTAL AREA=0.1173 SQ IN
△ 21-0.265-IN. x 0.03125-IN. JETS - TOTAL AREA=0.1740 SQ IN
AERATION-GAS RATE,-SCF/MIN.
GROSS AERATION-GAS VELOCITY, FLOWING FEET/MIN. @ 200 PSIG.

HEIGHT OF AERATED OIL as a function of gas flowing. Fig. 2.

urated oil remaining above the test plate was measured under test pressure at the end of each run. This height varied only slightly between most of the runs, and averaged 4.65 in.

Test results . . . Results of a test-series characteristic of the aeration relationships are shown in Figs. 2 and 3. This particular series was run on the 159-molecular-weight oil, employing all four test plates.

In Fig. 2 we have plotted the average height of the main aerated oil body against standard cubic feet per minute and corresponding gross flowing feet per minute of aeration gas for each plate. At the lower gas rates the volumes of aerated oil surged over several inches of height, due to rhythmic expansion and release of the ascending gas bubbles. At the higher gas rates liquid jets were intermittently projected upward for several inches from the agitated surface of the main oil body.

The plotted points of Fig. 2 represent our best visual estimation of the average height of the surging body of liquid for the low gas rates, and the average height of the irregular main-body surface at the higher rates. Fig. 3 shows comparative photographs for the 10/64-in., 6/64-in., and rivet plate aerated liquids at four key velocities of Fig. 2.

As is immediately apparent from Fig. 2, the character of change of aerated-liquid physical state with steadily increasing gas rate was found to be surprisingly different over three distinct ranges of gross gas velocity.

Low Gross Velocity

Over the low velocity range, up to 13-15 gross flowing feet per minute (up to 2.4-2.8 s.c.f. per minute of aeration gas), the volumes of the aerated-liquid bodies INCREASED RAPIDLY with increased gross gas velocity for all plates. Degree of increase for any given velocity progressively increased in going from the 10/64-in. to the 6/64-in. round-hole plates, but remained substantially identical for the 6/64-in. and rivet plates. The maximum expansion of the 6/64-in. and rivet-plate oils for this phase could not be determined, due to inadequate length of the 24-in. tube.

Throughout this initial-phase range, the aerated liquids for all four plates remained in a classical "continuous state." The ascending vapor streams were dispersed in the liquids in the form of separated bubbles which increased in size as they rose through the lower portion of the liquid zone.

We did not determine by direct experimentation the cause of the differences in degree of expansion exhibited by the various plates. However, it is our opinion that jet cross-section area was the dominating factor. In any case, the main-body gas velocities of this range were appreciably lower than normally encountered in even older low-capacity absorbers.

The 2.5-s.c.f. per minute picture group of Fig. 3 shows the similarity of the 6/64-in. and rivet-plate aerated oils, and their marked difference from the 10/64-in. plate oil. Also, these pictures clearly reveal the smooth top surfaces

maintained on the aerated-oil columns, with no indication of any "breaking through" of liquid jets or free-liquid droplets.

Medium Velocity Range

Over this velocity range, between 13-15 and 35 gross flowing feet per minute (2.4-2.8 and 6.5 s.c.f. per minute) the volumes of the aerated-liquid bodies DECREASED with increased gross gas velocity for all plates. The respective volume differences diminished rapidly with increased gross velocity.

Paralleling this volume shrinkage, the aerated-liquid states underwent a steady transition from the simple continuous-liquid phase of the preceding operation to an extremely complex state. This apparently consisted of an intricate mixture of gas bubbles and small liquid "blobs," around and through which the main gas stream ascended in a number of irregular continuous paths. With the completion of this transition, liquid jets and free-liquid droplets began to break through the main aerated-body surface, and a thin, fine mist began to appear in the gas stream leaving the aeration tube.

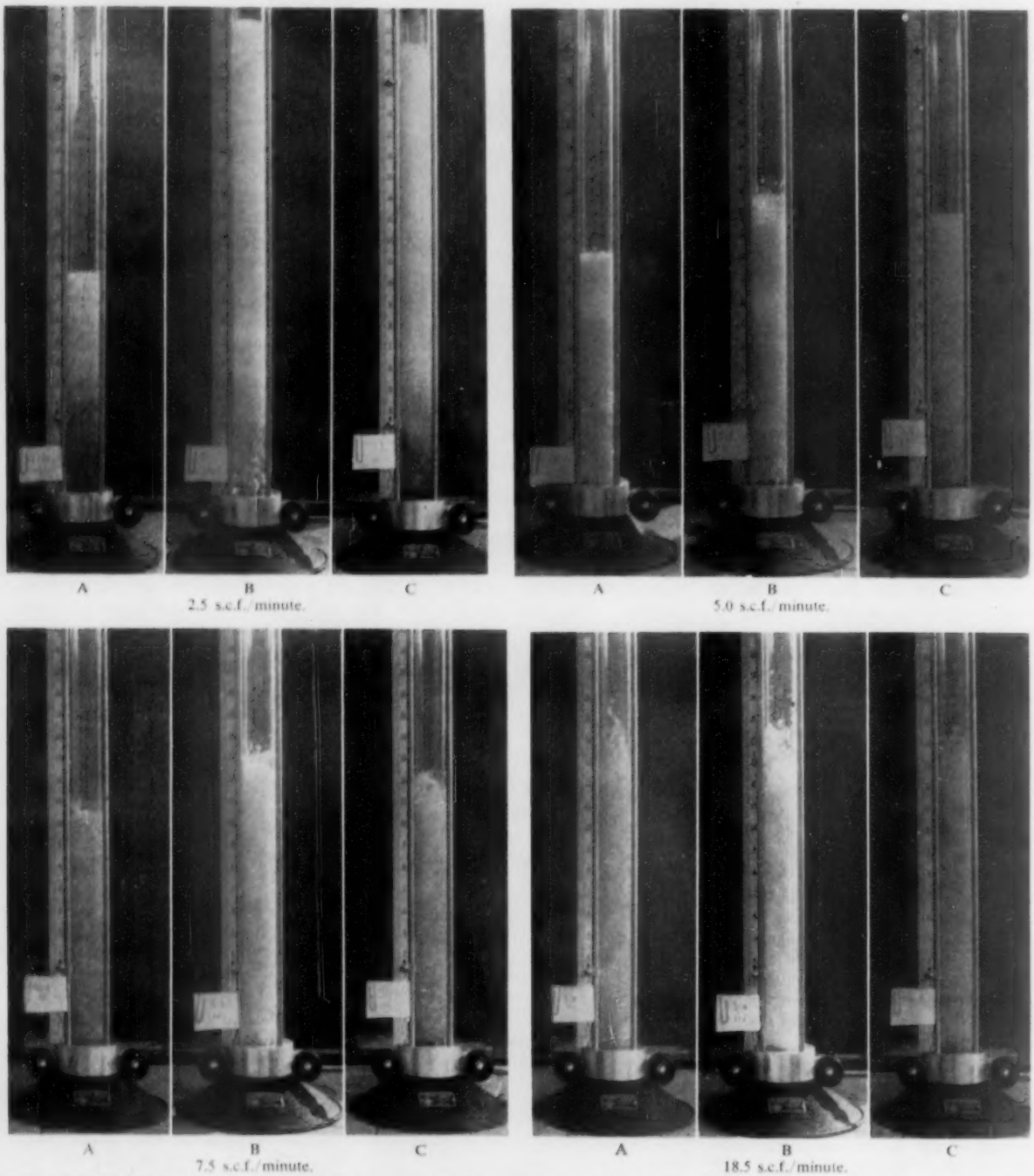
The 5.0 and 7.5-s.c.f. per minute picture groups of Fig. 3 bracket the zone of completion of this transition. Inspection of these two picture groups clearly reveals the initial development of liquid jets at the surfaces of the 7.5-s.c.f. per minute group vs. continued maintenance of "flat" surfaces for the 5.0 s.c.f. per minute group. (Note that the "splotches" and lighter-area section above the darker liquid-body in the case of the 6/64-in., 5.0 s.c.f. picture represent thin "froth" films clinging to the inside surface of the aeration tube.)

High Velocity Range

Over the velocity range between 35 and 100 gross flowing feet per minute (6.5-18.5 s.c.f. per minute), the "main-body" volumes of aerated liquids INCREASED ONLY SLIGHTLY with a THREEFOLD increase in gross gas velocity. There was no detectable difference between the four plates' physical states above 55 flowing feet per minute. At the same time, the mass and height of liquid jets projected above the main-body surfaces; the size, number and height of free droplets thrown into the gas space; and the density of the mist leaving the tube in the exit-gas

TABLE 2—TEST-PLATE DATA

Hole size—	No. holes	—Individual orifices— Area, sq. in.	Velocity ratio	—Total orifice area— Sq. in.	Per cent
10/64 in., i.d.	17	0.01917	1.00	0.3259	100.0
8/64 in. i.d.	17	0.01227	1.56	0.2086	64.0
6/64 in. i.d.	17	0.0069	2.78	0.1173	36.0
0.265 by 0.03125 in.	21	0.0083	1.87	0.1740	53.4



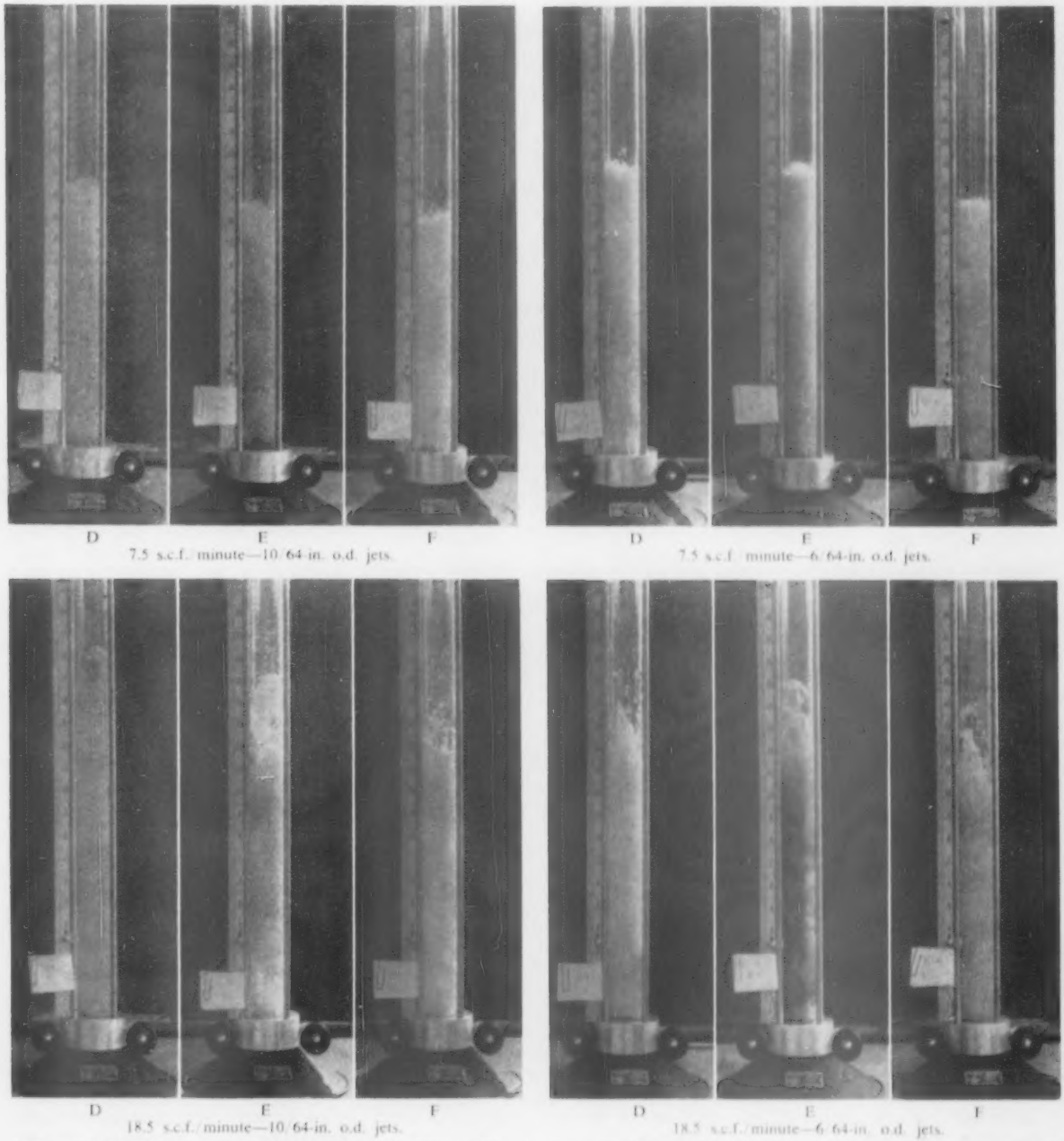
AERATION RESULTS, 159 M.W. oil at 200 psig. A = 17, 10/64-in. o.d. jets; total area, 0.3259 sq. in. B = 17, 6/64-in. o.d. jets; total area, 0.1173 sq. in. C = 21, 0.256 × 0.03125-in. jets; total area, 0.1740 sq. in. Fig. 3.

streams, all increased steadily with increased gross gas velocity.

The 18.5-s.c.f. per minute (100-flowing feet per minute) picture group clearly reveals the similarity of the different test-plate aerated oils at the maximum gas velocity employed. At this velocity the main-body levels averaged 12.5-13.0 in. in height; the peaks of the liquid jets attained a maximum of some 17½ in.; and the majority of free droplets were thrown to a "weighted-average-height" of 20 in. in the tube.

At the same time, the "free-flowing" mist leaving the tube was so dense that operation at this maximum rate for a relatively short period of time resulted in a substantial liquid loss. This clearly shows why efficient mist extractors should be installed in the tops of all absorbers operating at even moderately heavy gas loads.

Results with three oils . . . While Figs. 2 and 3 concentrate on a single oil, Fig. 4 presents four picture groups covering the three test oils of Table 1. These pictures were taken with the 10/64 and 6/64-in. hole test plates employing gas rates of 7.5 and 18.5 s.c.f. per minute respectively — which rates bracket the "active-tray" velocities employed by the majority of current commercial absorbers.



AERATION RESULTS, oils of different molecular weights at 200 psig. D = 159 M.W., 40.2° A.P.I. E = 185 M.W., 38.1° A.P.I. F = 208 M.W., 38.1° A.P.I.

The agitated-oil physical states are similar under equal main-body gas velocities and markedly different entrance-jet velocities for all three oils. This is particularly noticeable at the higher gas rates.

On the basis of the uniform physical-character patterns of the aerated oils produced over the wide range of operating conditions in the tests, it is apparent that entering-jet vapor velocities, as such, play little or no part in the establishment of column-tray efficiencies in high-capacity columns. Instead, the dominating tray-efficiency factor as far as vapor-loading is concerned, is turbulence. Specifically it is the degree of OVER-ALL contact-zone turbulence developed by the AVERAGE velocity of the vapors as they flow UPWARD through the MAIN BODY of the tray contact zone.

Acknowledgment

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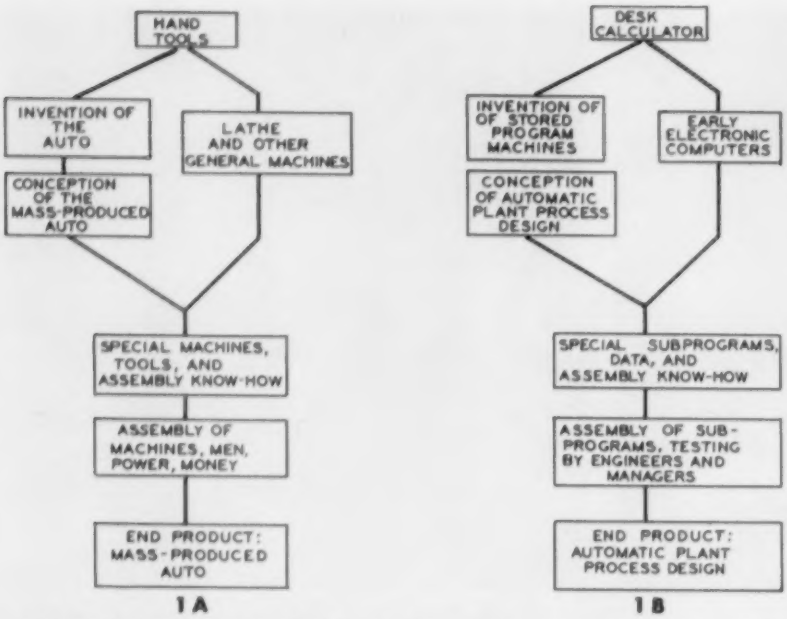
HAND TOOLS
INVENTION OF THE AUTO
LATHE AND OTHER GENERAL MACHINES
CONCEPTION OF THE MASS-PRODUCED AUTO
SPECIAL MACHINES, TOOLS, AND ASSEMBLY KNOW-HOW
ASSEMBLY OF MACHINES, MEN, POWER, MONEY
END PRODUCT: MASS-PRODUCED AUTO
1A
DESK CALCULATOR
INVENTION OF OF STORED PROGRAM MACHINES
EARLY ELECTRONIC COMPUTERS
CONCEPTION OF AUTOMATIC PLANT PROCESS DESIGN
SPECIAL SUBPROGRAMS, DATA, AND ASSEMBLY KNOW-HOW
ASSEMBLY OF SUB-PROGRAMS, TESTING BY ENGINEERS AND MANAGERS
END PRODUCT: AUTOMATIC PLANT PROCESS DESIGN
1B

SIMPLIFIED BLOCK DIAGRAMS illustrating progressive development of two end products: 1A—Mass-produced automobile. 1B—Automatic plant process design.

Computers Score on 2 Counts

1. Help engineer set up his problem
2. Solve problem once it's set up

by Elliott I. Organick

ELECTRONIC computers can revolutionize aspects of process engineering in the natural gasoline industry just as they have in accounting and other data processing fields. In fact the revolution in process engineering has already begun. The quality and quantity of engineering achievement (productivity) is rising due to the use of electronic computers.

Computers have proved useful on two levels: to help the engineer in setting up his problem and to solve the problem once it is set up. This two-fold quality combined with the ability of the new machines to store and retrieve readily vast amounts of data and instructions attracts us compellingly to the electronic computers for really elaborate calculations.

Engineer's aid . . . Computers offer a new way of accomplishing tasks of the engineer. In the past our references were books on shelves, full of methods, formulas, charts, ideas set down by others for us to follow and improve upon. If we continue to follow the growing trend in utilizing electronic computers, the engineer will have an additional library available: a library of engineering methods and formulas, written in the language of the computers.

We can store this new library within the computer or within reach of the computer. Upon proper command by the operator the computer performs the engineering task we wish it to perform. The operator will decide within the limits of the machine what engineering calculations are to be performed, and then command a computer to perform them.

Thus efforts in managerial pursuits, or to free them from routines, giving them time for thought and actions in what ought to be their major preoccupation: basic research and development work.

Reaching the ultimate use of computers will require a considerable technological development. We can gain a perspective of what needs to be done by comparing the projected development of the techniques on an electronic computer to accomplish an automatic plant design with the development of the mass production technique in the automobile industry.

The automatic plant design might be a desirable end product of electronic computers in process work. Let us then pair off common elements of these two developmental processes. In this way we see which elements in the development of the ultimate use of computers for engineering remain to be achieved. We can also judge for ourselves if we can reasonably expect these remaining elements to be achieved.

Fig. 1 contains simplified block diagrams illustrating the progressive development of the two end products. Little need be said of the block diagram, 1a, showing the development of the mass-produced auto. This is history. Diagram 1b shows how we have progressed from the desk-calculator stage (handtool stage) toward automatic plant design.

Early Work With Computers

The term, "early electronic computers," in the chart refers to the punch card computers such as the I.B.M. 604, C.P.C., and the Remington Rand 409. These machines were and are still used successfully by process engineers. Using this equipment they:

1. Learned basic concepts and know-how of electronic computing.
2. Learned the necessary interplay of engineering and numerical analysis, (here defined as the technique by which one can reduce higher mathematics to sequences of simple arithmetic and logical steps).
3. Produced routines or programs with which they could make the early computers perform automatically many process calculations such as fractionator, absorber and heat exchanger calculations.

In the natural-gasoline industry, the use of the early electronic computers began around 1950 and has been intensified since. These years were paralleled by the development of a new kind of electronic computer called the stored program computer.

Stored-Program Computers

These machines differ remarkably from the early electronic computers. They are more powerful, i. e., they are capable of producing more valuable results. For the gasoline industry in particular it has become apparent that, with the aid of stored-program machines, one can look forward for the first time to achieving the elaborate calculations necessary for an entire

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plant process design automatically and in reduced time spans that will produce major economies.

The conception of such a vast automatic calculation process is a long way from being an accomplished reality. Furthermore, the fact that stored-program machines make possible such elaborate electronic computations does not in itself justify developing them. The automatic plant design is used for illustration only; for there are many valuable uses of computers in this industry which are practical and feasible immediately, such as operations analysis and plant control.

Since the use of stored-program machines presupposes the laborious translation of engineering and analysis processed into the "language" of the machines, we might ask ourselves: what exactly makes these machines so attractive to the engineer and to the financial leaders of our industry? Here are some of the more obvious essential qualities and abilities of stored-program machines:

1. Ability to store large amounts of data and retrieve any particular portion of it in minimum time.

2. Ability to store elaborate and intricate lists of instructions in the form of numerical codes.

3. Ability to retrieve these instructions and execute them one at a time at high speed, and at any given time know the location in the memory of the next instruction which must be executed.

4. Ability to perform arithmetic and logical operations on instructions which are stored as numbers, as well as on data which are also stored as numbers. This permits computation of anything which can be done numerically, as well as the choice of what to compute at any given time.

5. Ability to use the machine to assist in preparation of the desired sequence of instructions. Machines can be used for: (a) assembling instructions, (b) translating instruction lists prepared for one machine into numerical codes of other machines, and (c) ultimately writing the elaborate list of instructions from simpler statements of the problem.

6. Ability to build up solutions of large problems made up of smaller problems whose general solutions have been worked out in advance as shorter lists of instructions called subroutines and subprograms.

7. Tremendous advantage in speed. Cost per arithmetic operation decreases with increase in the basic speed of the machine.

8. High degree of reliability.

Field Processing

"The subprograms are valuable in themselves. They can be and are being put to immediate use while larger developments continue. Subprograms for flash calculations, absorber calculations (plate-to-plate and short-cut), other tower calculations, and computations for heat exchangers, pump and compressor horsepower, etc., are now or soon will be performed routinely on stored-program machines."

New employments . . . Returning to the block diagram for development of the automatic plant process design, Fig. 1b, the next step in the development of the envisioned end product is or will be a merger of the increased potential of the new stored-program equipment with the knowledge, experience, and results gained in working with the early computers. This combination is already resulting in the development of essential subprograms, rearrangement of engineering data into forms more easily handled by computers, and establishment of knowhow for assembly of subprograms and data.

The subprograms are valuable in themselves. They can be and are being put to immediate use while larger developments continue. Subprograms for flash calculations, absorber calculations (plate-to-plate and short-cut), other tower calculations, and computations for heat exchangers, pump and compressor horsepower, etc., are now or soon will be performed routinely on stored-program machines.

To be most valuable in the long range, many subprograms will be prepared in as "general" a way as possible. A subprogram for a fractionator design, for example, would be generalized if it is developed to handle multiple feed. In this way the case of a single feed can be handled as a special case.

Generalizing in this manner still further one can develop subprograms which consider multiple product withdrawals, multiple heat-withdrawal points, multiple heat input. Thus the truly general subprogram is of increased value because the cost of development can be justified by being applicable to a greater number of main programs.

Tower calculations . . . I understand that Humble Oil & Refining Co. will present publicly next month a description of a general tower calculation for a stored-program machine handling mixtures with up to 20 components for towers of up to 100 plates, with or without heat balance on every plate. This is a good example of a generalized program, which can be utilized as a starting point for many calculations pertaining to tower design and performance.

A great deal of work is being done to assemble the necessary engineering data in such a way that when stored in the machine, the subprograms can call for these data when they are needed. Enormous amounts of data must be translated so that it can be conveniently stored in machines.

A good example is the need to store large numbers of K values and enthalpy data in the memory of an electronic computer. One method which has been considered and is being followed for reducing the storage requirement is to find equations (large and complex polynominals) which fit the K curves and the enthalpy curves.

The coefficients of these equations, together with subprograms for computing K or enthalpy from the coefficients, must be also stored and made available to the larger subprograms when they are needed. Reducing so many curves, tables, etc. of engineering data to equations is itself a sizeable job and has required an electronic computer. In addition, a subprogram which will permit the computer to perform the job of curve fitting is also necessary.

When the subprograms and data are to be used as building blocks of more elaborate systems, it is easy to see, therefore, that the blocks must fit together well when they are later assembled. Finally, the assembled blocks or subprograms must be tested for accuracy and examined for usefulness and economic value by engineers and managers. Passing this stage the end product of electronic computers, which in our case is the program for automatic process design of a gasoline plant, will be ready for routine use.

Conclusion

We are moving through a vast technological development whereby engineering know-how in terms of data, working charts, calculation procedures, etc., will be stored in a well-ordered manner in the memory of machines. Upon relatively simple sets of commands from us, these machines will be capable of executing highly intricate and elaborate processes. Hence process calculations, which we know to be quite elaborate in natural-gasoline design and performance, may be executed more and more completely by computers.

MAGNETIC-DRUM COMPUTER used by Phillips at its Bartlesville, Okla., computing laboratory. Fig. 1.

DATA PREPARATION and data transmission areas at the Phillips computing laboratory. Fig. 2.

Natural Gasoliners Like Robot Calculators

Here are some of the ways the instruments prove useful . . . for example, solving a 50-stage fractionator within 2 hours

by J. R. Cobb and R. L. McIntire

PHILLIPS PETROLEUM CO. has established a mathematical engineering group in the research and development department to solve problems in process design, equipment design, production, operations research, and quality control using automatic computers. The present installation uses a medium-sized computer of the magnetic-drum type.

With this machine, a step-by-step solution of a 50-stage fractionator can be produced within 2 hours. By comparison, the former machine (a card-programed calculator) could compute a solution in 10 to 20 hours. A man making a hand solution would never obtain the precision of the machine, but even a rough step-by-step calculation checking several reflux ratios would probably require 6 weeks to 3 months.

One of the problems which lends itself particularly well to machine calculations is absorber design. The complications of intercoolers, widely varying vapor rates, and the absorbing effect of heavy components in the feed are easily computed. The machine solution is simply a series of passes down the column for different assumptions of the overhead composition until the calculated vapor to the feed step equals the absorber feed.

In the case of reboiled absorbers, revisions in the product streams are made by comparing the vapor streams at the feed step as calculated from both the overhead and the bottoms product. Each step is calculated by trial and error. A temperature on the step is assumed and a corresponding heat balance is made until a temperature is found which will satisfy both heat and material balances.

Process design . . . The separation of hydrocarbons is of extreme importance to Phillips and the entire gasoline industry. Sharp separations requiring a high purity of products are characteristic of the petrochemical productions. The design of absorbers, strippers, stills, and rich-oil deethanizers has long been a time-consumer for the engineer in process design work.

Immediately coupled with the problem of designing a fractionation column is the evaluation of thermodynamic data. Here, we have used reduced correlations and lengthy empirical equations of state in efforts to interpolate and extrapolate experimental P.V.T. data. These methods, where they are successful, are of tremendous importance since such correlations can be used with the thermodynamic equations of state to derive consistent enthalpy and equilibrium data.

Calculations aimed at the design of thermal or catalytic crackers place great demands on the mathematical engineer. The design of the number of tubes in a thermal cracker, for example, requires a combination of kinetics, heat transfer, and pressure-drop correlations.

Equipment design . . . One of the everyday problems of our engineering departments is the design and construction of pipelines. The stresses and strains in critical bends must be computed. The pressure drop expected in long sections must be estimated and horsepower required for a gas-accumulation system must be predicted.

Consumers for fractionators are to be sized by computing with the heat-transfer coefficient which exists in the two-phase systems. One of the ugliest problems in unsteady state raises its head when control instruments are to be located properly on a unit. Here, transient effects give rise to differential equations and their corresponding problems in boundary conditions.

Authors are in the research and development department, Phillips Petroleum Co., Bartlesville, Okla. Paper presented at annual meeting, Natural Gasoline Association of America, Fort Worth, April 11-13.

Field Processing

Production . . . One of the most severe economic problems in the petroleum industry is the location and subsequent recovery of oil and gas from the ground. Many companies justify large computing installations for this one field alone. The geophysicist must use mathematical models to design equipment necessary for seismic surveys and to interpret the results of these surveys.

The current price of drilling a well (whether it is dry or not) approaches or surpasses the purchase price of one of the medium-sized computers we will soon describe. Accurate estimates of the effects of fracturing a well, of steam injection, of water flooding, and of acidizing (to mention a few cases) promises to yield very quick payouts for the mathematical work involved.

In the reservoir, the radial flow of fluids through the porous rock must be predicted. Once the oil is above the ground, further conservation must be practiced by determining the most favorable method of stabilizing the oil. Flash pressures and temperatures and flash-tank orientations must be studied. In some instances, simple fractionations in the field are profitable and these cases each need examination at the desk of the engineer.

Operations research . . . Recent literature in the trade journals and in strictly mathematical publications alike have emphasized the attention which is being given to a technique called mathematical programing. Here, we study company operations through the eyes of mathematic models.

Although the theory of these techniques can become involved, the actual numerical operations which are performed are extremely simple. For example, the optimum transportation of L.P.G. from, say, 50 origins to 400 destinations is a linear problem which does not require a division for its solution. Several hundred thousand additions and subtractions are necessary.

The blending of motor fuels and avgas for maximum profit and simultaneous acceptability is a second example of a typical operations research problem. Optimum orientation of units in a refinery for improved recovery and profit specification is a problem which is now receiving attention within our company.

Quality control . . . The title of mathmatical engineering might be interpreted to imply the use of more sophisticated methods than are actually practiced. Many of our problems are simple arithmetic and (if it were not for their volume) could be solved without difficulty. Heat and material balances around units and entire plants are typical of the routine problems which confront the operating engineer.

Molar analyses are obtained from the peak readings of a mass spectrometer only after the solution of a set of linear simultaneous equations. Infrared analyses require the repetitive solution of a similar set of equations. The pilot plant or commercial plant engineer is always searching for correlations of his data and statistical methodology is characterized by its simplicity simultaneously combined with an overwhelming volume of arithmetic.

It is in this area that the habit of solving problems systematically is extremely inmportant. Those who work with computers rapidly acclimate themselves to this necessity for restating many diverse problems on a more generalized, common basis.

Equipment Requirements

For the past 3 years, we have operated a card-programed calculator on two shifts in the research and development department of Phillips Petroleum Co. Since this machine is one of the first computers to be mass produced for scientific uses, it is also one of the easiest to operate and program. Ours is a very successful experience . . . during the entire 3 years we averaged less than 5 per cent down time for machine maintenance and absolutely no down time due to the lack of problems.

As we grew in experience, our "customers" from all departments in the company grew in number. With this increasing backlog of problems and confidence, we ordered and have just recently placed in operation a larger, so-called medium-sized computer. Since many readers may not be familiar with the equipment required to solve the variety of problems given in the preceding section, a brief description of our installation follows:

Main computer . . . Our computer is an internally programed, electronic, magnetic-drum computer. It has a memory (magnetic drum) capable of storing 4,080 words (10 digits plus a sign). These words are either the data on which the machine operates or the commands which it obeys. Some 54 internal commands are available and these include all of the arithmetic functions and many logical operations such as sign test, zero test, shift right or left, etc.

In addition, subroutines stored on the drum permit the use of auxiliary commands which cause the machine to take roots, compute logarithms, or evaluate any of the common trigonometric functions. The machine's normal mode of operation is in fixed decimal arithmetic but, again, subroutines make it possible to solve problems in which the numbers vary from 10^{-50} to 10^{50}. Most operations require 2 ms. to complete; however, some of the more complicated functions require from 50 to 200 ms. to compute.

Input and output channels . . . Our computer operates with keyboard, paper tape, and card input and with paper tape, card, typewriter and line printer output.

Our normal method of using this variety of channels is as follows: (a) the "algebra" of the problem (the program) is read into the machine on paper tape; (b) if necessary, minor changes are made on the drum by the operator at the keyboard; (c) specific data pertaining to the case at hand are called for from cards; (d) a detailed listing of the answers is printed out by the relatively fast line printer; and (e) a summary of the results, with alphabetical interpretation, is typed out by the relatively slow electric typewriter.

Frequently, the typewriter is used to print out operator instructions only and the finished answers are left to the line printer.

Data communications networks . . . Since we are operating an engineering computing facility for the entire company, the problems of communications are extremely important. Most of our problems are stated to us orally and, if they have already been analyzed and coded for the computer, the data are entered onto prepared forms. These forms are complete in every detail . . . from a description of what the machine routine can compute to specific instructions for the operator.

For these problems which originate at other physical locations, we depend on teletype, telephone, and a data transceiver. For example, a complete data-transmission system is now in operation between one or our mass-spectrometer laboratories and our machine-computations laboratory. Via an analog to digital converter, results from a mass spectrometer are automatically converted into punched-card form.

These peak readings with their calibration identification are transmitted to our computing laboratory by the transceiver and are there received in new punched cards. These latter cards are used in the computer and the answers (on punched cards) are relayed back to the point of origin.

Although there are almost 500 miles between the terminals of this link, results (almost literally untouched by human hands) are returned in time to

answer onstream operating problems in important plants.

Space requirements . . . Our computing laboratory occupies a little over 1,100 sq. ft. in our main offices at Bartlesville, Okla. Although this room is somewhat crowed, we believe that there is still some space left for the additional equipment we will need to install later.

Fig. 1 is a view of the computer with the operator's console in the foreground. Fig. 2 is a view of that part of the room which is devoted to data preparation and transmission. All engineering and mathematical aspects of analyzing, programing, and coding a problem for the computer are conducted outside the computing laboratory proper.

. . . How the computer solves a problem

As an example of the type of approach which is made to engineering problems, absorber design is fairly typical. The solution is a simple one involving no complicated mathematics. Since the machines operate rapidly and since coding a program for a machine is relatively time consuming, we have generally used as simple a program as possible.

Our operating departments give us many of their absorber design problems because these problems are usually more complicated and harder to estimate by short-cut methods than fractionators. The effects of intercoolers, changes in vapor loading, and heavy components in the feed acting as an absorbent are difficult to guess without some sort of step-by-step solution.

Method of solution . . . The machine takes much the same approach to absorber design that a man making a step-by-step solution would take. The overhead quantity and composition as well as the oil rate are estimated. It is then possible to calculate down the column to the stripping section in the case of reboiled absorbers or the column botoms in the case of simple absorbers.

This calculation is considered a single pass. After each pass, the computer computes the ratio of the vapor to the feed step as calculated on the up pass. When these ratios equal unity, the column is solved. Until they are one, the computer keeps changing the estimated overhead and bottoms and making new passes.

This method of design assumes that the number of ideal steps and the oil rate have been set by the design engineer and the separation is to be computed. This is the easiest problem for the machine to solve since the fraction absorbed of any one component is a constant or almost a constant from one pass to the next. Thus the machine can easily guess a new overhead based on the absorbing factors in the preceding pass.

However, the most common problem is to determine the required oil rate when the number of ideal steps and the separation are fixed. At present, the separation is determined at several different oil rates until the best one is found.

Each individual pass is based on the following steps:

1. Estimate overhead vapor composition and quantity.

2. Estimate absorbent oil rate, composition and temperature.

3. Guess the temperature of the top ideal step.

4. Based on this temperature, calculate the composition in the liquid on the top step for the components other than the absorber oil, ($x = y/K$).

5. $1-\Sigma x$ of the lighter components equals x of the oil.

6. Total liquid from the top step equals the oil flow divided by the concentration (x) of the oil. In most of our problems, the oil can be considered nonvolatile.

7. The amount of each of the lighter components in the liquid from the top step can then be calculated by multiplying the mole fractions in the liquid by the total mols of liquid.

8. The composition and quantity of the vapor from the next lower ideal step can then be calculated by a material balance.

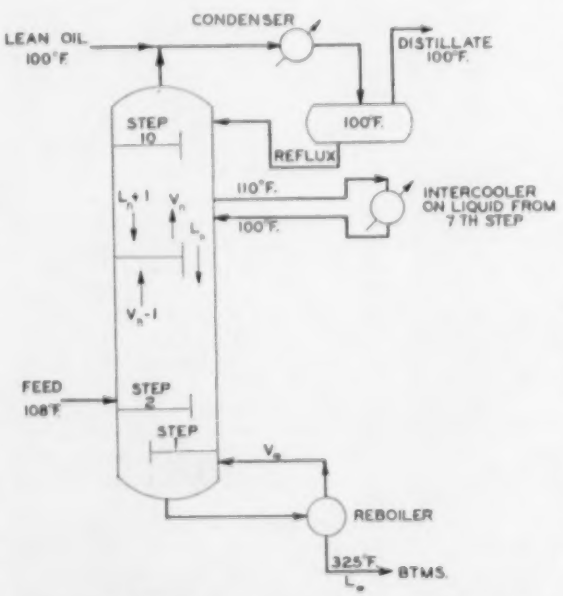
9. Now that all of the material in and out of the step has been calculated, a heat balance can be made if the temperature on the step below is known. Fortunately, the column calculations are not sensitive to this temperature.

On the first pass, the next lower step is estimated a few degrees warmer than the tray being calculated. (The temperature of these steps cannot be obtained by a dew-point calculation since the temperature is very sensitive to errors in the small amount of oil in the vapor).

On all passes after the first, the temperature on the lower step is estimated from results of the preceding pass. These guesses usually prove to be accurate to within ½ ° on the second pass.

This heat balance indicates the amount of error in the guess of the top step temperature. If the heat does not balance, the machine will guess a second temperature several degrees higher. From the heat balance obtained on this second temperature guess, the computer extrapolates the results and guesses a third temperature which usually does satisfy the heat and material balances.

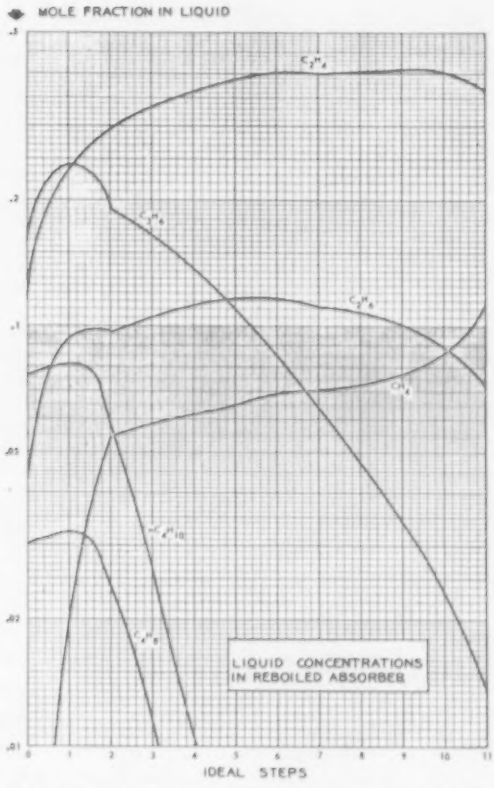
10. At this point, the liquid falling to the second step is completely specified and the composition and quantity of the vapor rising from the step are set. The computer returns to item 3, above, and continues on down the column.



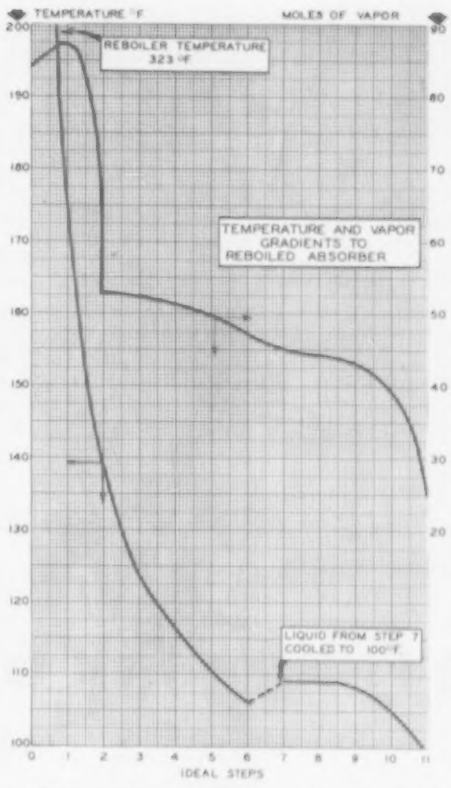
SCHEMATIC OUTLAY for typical absorber problem. Fig. 3.

The assumption of a nonvolatile absorbent is usually safe in the absorbing section where the temperatures are low, particularly in cases where mineral seal oil is the absorbent. In the case of a light absorbent, it is necessary to get a preliminary estimate of the step temperature and then recalculate the vapor based on the presence of the oil.

To make the actual computations, the enthalpy and equilibrium points are read into the machine and converted into curves. After this step, the program tape (containing the algebra)



LIQUID CONCENTRATIONS on the various absorber trays. Fig. 4.


TEMPERATURE °F
MOLES OF VAPOR
REBOILER TEMPERATURE 323 °F
TEMPERATURE AND VAPOR GRADIENTS TO REBOILED ABSORBER
LIQUID FROM STEP 7 COOLED TO 100°F
IDEAL STEPS

VAPOR LOAD and temperature distributions, absorber problem. Fig. 5.

Field Processing

and the column specifications (such as absorbent rate, number of ideal steps, or desired separation) are read into the machine. Then the machine operates without technical intervention until a solution is reached.

A rich-oil deethanizer was chosen for illustrational purposes although this particular design does not necessarily represent the most economical method of making the desired separation. Preceding this rich-oil deethanizer, there is a simple absorber and this absorber bottoms product is to be partially deethanized in the example reboiled absorber shown in Fig. 3. Specifications and results are given in Table 1.

The specifications included number of stripping and absorbing steps, lean-oil rate and composition, pressure, use of a condenser and one intercooler, condenser, feed and intercooler temperatures, and a general idea of the desired split.

From these data, the machine computed the column split, a heat balance, a temperature gradient, and vapor and liquid concentrations and rates for every step in the column. The liquid concentrations on each step were plotted on Fig. 4. The vapor load and temperature on each step are plotted on Fig. 5.

This description should give some idea of the information which can be obtained with the automatic computer. Note that in this case the column has been assumed to be adiabatic. As a matter of fact, the computer can easily solve absorbers where losses are known to occur. Other refinements of this computational method are possible and we have, in certain cases, solved columns with two liquid phases and with nonideal volatility relationships.

Conclusions

The advantages of using computers which we have found are as follows:

1. **Precision.** The machine can calculate problems that a man working with a slide rule could never solve because of low precision.

2. **Reserve help.** The machine group forms an effective reserve to help design and operating groups throughout the company that find themselves temporarily overloaded.

3. **Speed.** The ability to get a good answer quickly is often very valuable in terms of increased production or quicker construction.

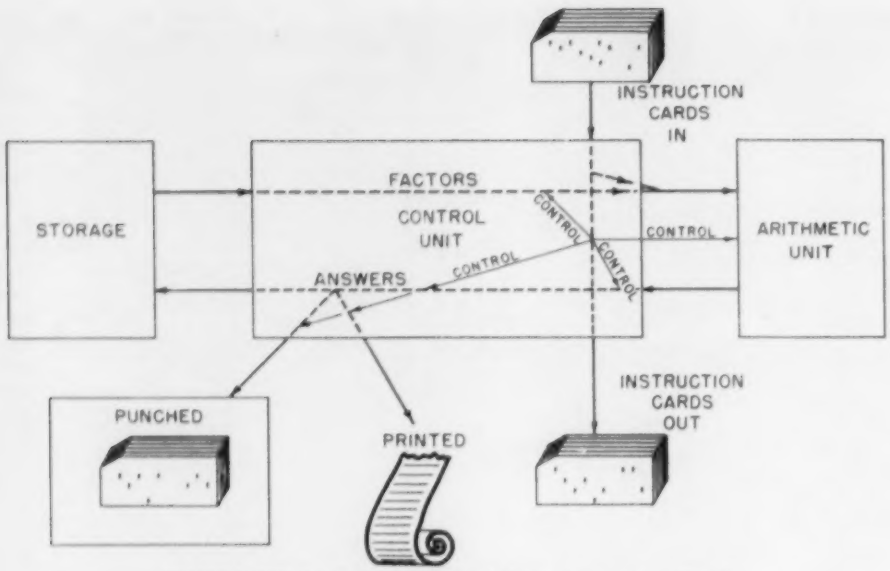
4. **Morale.** The computer frees the design groups from the tedious calculations and allows them to give more thought to the over-all design which most engineers prefer.

Acknowledgment

The authors wish to thank the research and development department of Phillips Petroleum Co. for permission to publish this paper.

TABLE I—ABSORBER EXAMPLE

Reboiler Absorber Specifications			Calculated Results		
	Feed (moles)	Absorbent (moles)		Overhead (moles)	Bottoms (moles)
Hydrogen	0.40	0	Hydrogen	0.40	
Methane	10.09	0	Methane	9.78	0.31
Ethylene	17.80	0	Ethylene	11.23	6.57
Ethane	5.17	0	Ethane	1.74	3.43
Propylene	12.26	0	Propylene	0.19	12.07
Butenes	2.31	0	Butenes		2.31
Butanes+	5.94	0	Butanes +		5.94
Mineral Seal Oil	34.00	13.0	Mineral Seal Oil		47.00
Total	87.97	13.0	Total	23.34	77.63
Feed temp., °F.		108	Condenser duty, M.B.t.u.		49
Vapor in feed, per cent		0	Intercooler duty, M.B.t.u.		18
Pressure, psia.		800	Reboiler duty, M.B.t.u.		1,432
Condenser temp., °F.		100	Feed enthalpy, M.B.t.u.		546
Lowest intercooling temp., °F.		100	M.S.O. enthalpy, M.B.t.u.		80
Steps in stripping section		2	Overhead enthalpy, M.B.t.u.		160
Steps in absorbing section		8	Bottoms enthalpy, M.B.t.u.		1,831
Reboiler		1	Boil-up ratio (Vo/Lo)		1.08
Condenser		1	Reflux ratio (R/D)		1.29
Total ideal steps		12			



COMPONENTS for the card-programed electronic computer. Fig. 1.

Operating Problems Yield to Electronic Brain

by J. C. Schneider and R. G. Wright

THE Midland exploration and production area of Shell Oil Co. has a card-programed electronic computer which is available to all the Shell engineering groups in the area, including the gas engineers, for use in solving technical operating problems. All types of calculation may be performed on an electronic computer, but lengthy, complex computations present the greatest savings in time of calculation.

Although it may seem contradictory, this fact is almost a disadvantage in gaining acceptance of electronic computers because the efforts of engineers for a long time have been directed toward simplifying complex problems and lengthy calculations are not required, particularly in operations. Therefore, the most valuable applications are calculations that are not being made at present, or work that is being done by some means other than calculation.

For example, process calculations are not usually made in solution of plant operating problems because too much time is required. With an electronic computer, such applications are feasible. Simple calculations can also be handled very advantageously by the computers, particularly if the problem is to be solved more than once. Gas engineering problems have included both complex and simple calculations.

Authors are with Shell Oil Co., Midland, Tex. Paper presented at 1956 annual meeting, Natural Gasoline Association of America, Fort Worth, April 11-13.

Small computer . . . The card-programed electronic computer is classified as a small computer, an indication of the development of computers in recent years. The components and their interconnections are shown in Fig. 1. To solve a problem on the electronic computer, the problem must be translated into machine language.

This is the big step in utilizing an electronic computer and various procedures are followed. In Shell's Midland computer installation, the problems are prepared for the computers by a data processing analyst, assisted by a data processor, both of whom work for our treasury department, which operates the accounting machines used in the area.

The first step in solving a problem on the electronic computer is to have the engineer prepare a clear statement of the problem and outline the manual calculations made. Then the problem is broken down into basic arithmetical steps that solve the problem when performed in the proper sequence.

Next, a set of coded, sequential instructions are written and punched into cards, which instruct the card-programed electronic computer in solving the problem. Programing may also include wiring special boards to utilize more electronic computations, which speeds up the calculation. The time spent in programing can vary widely but should aim at the least over-all time for solution. More programing time should result in a saving of machine time.

The engineers must work closely with the programer to achieve the best results and mutual education takes place as the programer becomes familiar with the calculations and the engineer becomes familiar with the operation, characteristics, and limitations of the electronic computer.

Gas problems . . . The gas department has had several problems solved on the card-programed computer. The first was a calculation of factors for converting 30 to 40 lb. R.v.p. gasoline volumes to 26-lb. R.v.p. volumes. These conversion factors are calculated each month for two plants from the fractional analysis of a sample of the gasoline produced during that month.

The calculation by desk calculator takes about 3 hours plus 1 hour for checking. The card-programed computer requires about 20 minutes machine time and about 5 minutes to check, the check being chiefly to see that the correct data were punched into the cards and to see that the machine functioned properly.

Another calculation involved the computation of pressure drops for various pipe sizes, lengths, and gas volumes using Weymouth's equation. The results were used to prepare a set of working curves for design of gas-gathering systems. Gas-gathering system pipeline-network calculations have

been set up for determination of the pipe size required to handle a volume of gas through a distance at a desired pressure drop.

A set of flash vaporization calculations were made during consideration of a refrigeration cycle gasoline plant. Only the composition and equilibrium ratio (K-values) were needed for the computation. The nine flashes needed to plot a grid of temperature and pressure with recovery were performed by the computer in about 8 minutes for each flash. The calculation indicates the condensation in the deethanizer feed tank which is proportional to the recovery in such a plant.

These problems mentioned have been relatively small, but the computers can handle all sorts of problems quickly, particularly when the calculation procedure has been set up. As the engineers become more familiar with preparing problems for the computers, they should be able to shift more calculations to the machines. Possibly calculation forms may be used to handle simple problems on a routine basis.

Gasoline-plant work . . . A more ambitious program, which is in progress, is to perform gasoline-plant process calculations on the computers. Applications could include prospective plant designs, checks of existing plants, and calculation of plant operating conditions under changing gas composition, gas volume, temperature, etc.—changes which are seasonal or result from changes in the gas produced by the field.

The programing has been set up to handle each column or unit operation as a unit of calculation. An absorber calculation is programed so that only the input data need be changed to calculate an absorber by the method which has been programed. Equilibrium flashes and other operations such as stripping, distillation, rich-oil deethanizer, etc., will be programed the same way. Therefore, the programing time can be reused by other problems.

Relatively short and simple calculation methods have been used in this work, chiefly because our efforts have been directed at evaluating performance of existing plants. Operating data were available which allowed neglect of factors which would be needed if generalized calculation methods were required. In the absorber calculations required thus far, the temperatures and pressures of the streams were available from plant data and the calculation of the hydrocarbons absorbed could be made without requiring heat balances.

In the future, more general calculation methods will be needed. More accurate methods could be used, too, but it is not necessary to change the calculation methods to use electronic computers. Tray to tray and other exact methods are more feasible on electronic computers but such methods are still lengthy in terms of machine time. A week's calculation in 5 to 6 hours is just as advantageous as a 6-month calculation in 2 or 3 weeks.

Lean-oil calculation . . . The first process-calculation problem required the determination of the economics of lean-oil circulation at a gasoline plant. This plant was designed to recover 60 per cent of the propane from 90 M.M.c.f.d of inlet gas, but the field at present is producing only 65 M.M.c.f.d. The plant has two parallel sets of stills and fractionators, but one set can handle the gas available with some loss in propane recovery.

The increased fuel cost and operating and maintenance cost were to be weighed against the increased revenue to be derived from operating the shutdown process area over a range of gas volumes, propane prices, and operating conditions in summer, winter, spring, and fall.

The process scheme is shown in Fig. 2; this is a two-still-type gasoline plant with 200 psi. absorbers. Both process areas use the same scheme, but the shutdown area is smaller than the one in operation. Essentially the problem is to calculate the propane recovery at two lean-oil rates over the desired range of gas volume and operating conditions because both areas operate at practically the same temperatures and pressures.

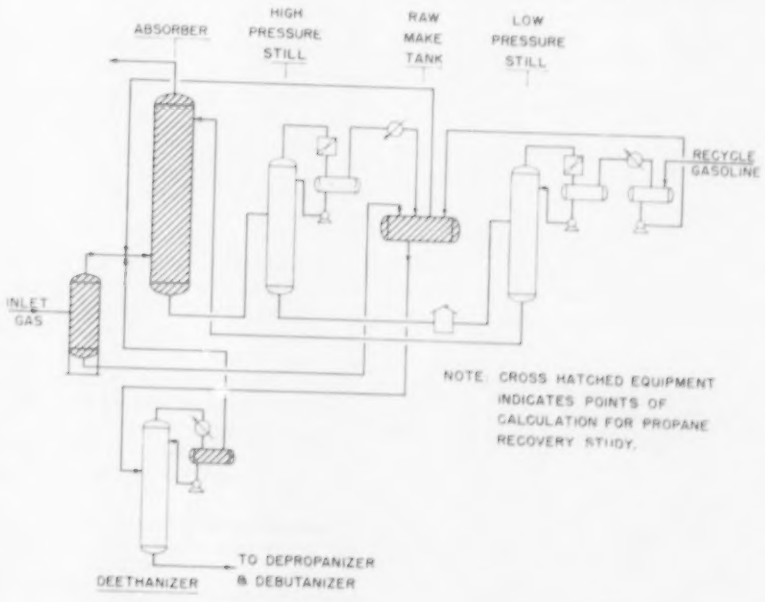
Recovery performance . . . The recovery performance for this plant can be determined by calculations at four points which are shown by the shaded parts of Fig. 2. The following calculations required are: (1) an equilibrium flash on the inlet gas; (2) the hydrocarbon absorbed in the absorber; (3) an equilibrium flash of the stream to the deethanizer feed tank; (4) and the volume and composition of deethanizer overhead vapors.

Operating data were available at these points so the only input information needed was the inlet gas composition and volume, the lean-oil rate, K values for the four calculation points, and the quantity and composition of the gasoline being recycled to the raw make tank. The deethanizer feed-tank vapors and the deethanizer overhead vapors are recycled to the absorber; recycling-type trial-and-error calculations are required that are quite lengthy.

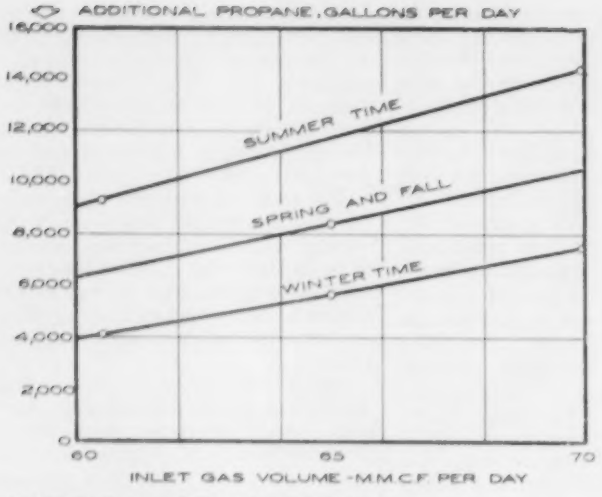
To calculate the recovery for one case would take about 3 to 5 days by desk calculator. Card-programed computer does it in about 5 hours. The programing of this calculation required about 2 days, but as mentioned before, the programing can be applied to similar problems and the method is available for additional calculations at this plant.

In setting up this calculation, the process engineer set down the equations and steps of the calculation. This plus sample calculations were given to the data processing analyst who prepared the problem for solution by the electronic computer.

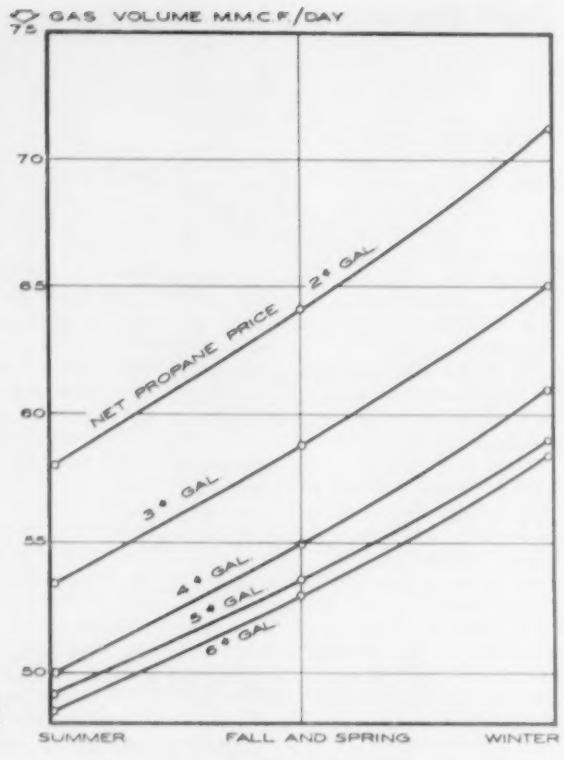
For this problem, there were 5,000 cards to be fed through the electronic



SCHEMATIC FLOW DIAGRAM for two-still gasoline plant. Fig. 2.



INCREMENTAL PROPANE RECOVERY as a function of inlet gas volume. Fig. 3.



MINIMUM gas volume for break-even operations. Fig. 4.

Field Processing

computer for calculation of one complete cycle. As programed, the machine operator handles this calculation without additional instructions. The machine handles 150 cards per minute; therefore, a case needing 6 cycles of calculation requires about 4 hours.

Flash calculations . . . The flash calculations use a method published by Rachford in Journal of Petroleum Technology, October 1952. The vapor fraction is found by successive approximation. An assumption is made and calculated, then the sign of a residue is used to guide the electronic computer to make the next guess either higher or lower. This method narrows the correct answer down to an interval, depending on the number of times the calculation is repeated.

The vapor fraction could be solved more quickly by using a special purpose control panel wired for each sequential operation; however, the general-purpose panels which were used provide more flexibility to the overall calculation without significantly increasing the required machine time. The card-programed computer uses a card for each step of a calculation. Thus, an 11-component flash requires about 1,600 cards.

The absorber calculation was based on the Brown-Kremser method, which is based on the bottom-tray conditions in the absorber. This method is accurate enough for 200-psi.-absorption, particularly when operating data are available. The lean-oil rate and gas volume were known, which requires a trial-and-error calculation to find the quantity of hydrocarbons absorbed.

The fraction absorbed was calculated from the absorption factor, using an equation published by Edmister, $(A^{n+1}-A)/(A^{n+1}-1)$. Engineers generally use a chart to find the fraction absorbed but the electronic computer requires an analytical expression. If only the curves were available, the computer could have been used to fit an equation to the curve.

Deethanizer flash . . . The deethanizer feed-tank required addition of the moles absorbed, the condensate from the flash of the inlet gas, and the gasoline recycle. Then the liquid from this flash was used to calculate the deethanizer overhead by assuming a contamination of ethane in the propane product and calculating the amount of propane needed with the ethane and lighter to reach the dew-point composition at the temperature and pressure in the deethanizer reflux tank.

The deethanizer overhead, the deethanizer charge-tank vapors, and the vapor from the inlet gas flash were added together and constituted the absorber feed for the next cycle. The calculations were repeated until the change on successive cycles in total gas volume to the absorber was less than a prescribed amount. About 7 to 10 cycles were needed.

The propane recovery was hand-calculated from the deethanizer feed minus the deethanizer overhead because the cyclic calculation did not require this answer. The results derived from the calculation are shown in Figs. 3 and 4. The incremental propane recovery from starting up this process area over a range of gas volumes and operating conditions is shown in Fig. 3.

The minimum gas volume to break even at various seasons and propane prices, ranging from 1 to 6 cents per gallon, are shown in Fig. 4. Using these charts, the economics of operating the shutdown process area can be readily determined when the gas volume and propane price are known.

Other problems . . . There are other problems in operation that will be solved when the calculation methods have been prepared for the electronic computer. Plant performance tests may be checked and the dependence on consistant analyses of the plant streams removed.

Summary

The card-programed electronic computer has proved useful in gasoline plant computations. Justification is primarily based on making available calculation methods which could not be applied before and not in direct manpower savings work already being done.

Reducing the calculation load on the engineer has the further benefit of making the engineer available for engineering work.

Thus far, only relatively simple process calculations have been performed on the electronic computer, but solution of more complex problems is planned for the near future.

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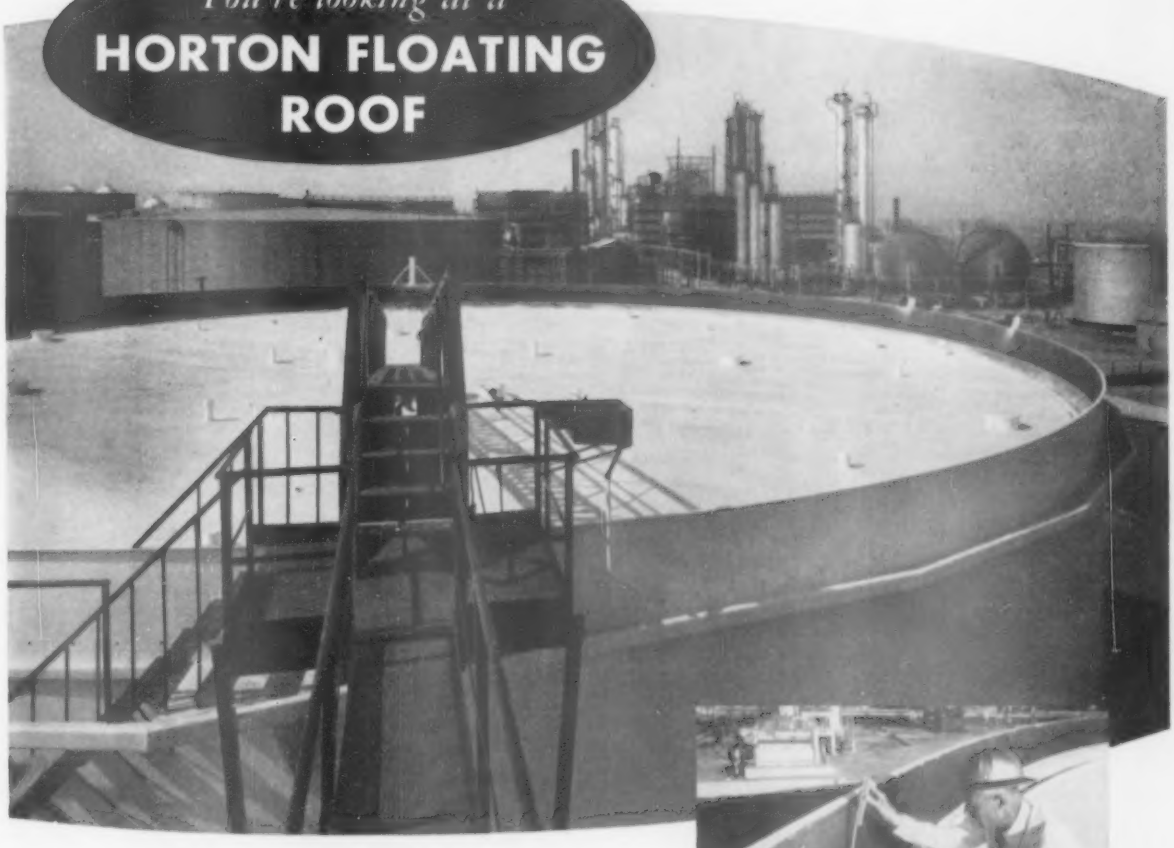

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Journal's Field Processing Survey Reveals That

L.P.G. Output Rose 11 Per Cent in 1955

by LaWanda Turner
District Editor

TOTAL production of all natural gasoline and liquefied petroleum gas in the United States during 1955 rose 6.3 per cent over 1954, with L.P.G. accounting for most of the gain. L.P.G. production rose nearly 11 per cent over 1954; natural gasoline rose 4 per cent; other (heavier) products dropped almost 3½ per cent.

Production of L.P.G. is running slightly ahead of natural-gasoline production. However, in this survey some field processing plants reported their combined natural-gasoline and L.P.G. production, without indicating a percentage breakdown.

To give our readers as accurate a picture as possible, the Journal has placed those combined figures in a separate column in the state summary table. In the individual-plant tables, the combined figure reported by each plant appears in the natural-gasoline column with a notation that it is a combined total.

Some companies reported capacity figures rather than actual production.

In the Journal survey, Colorado shows the biggest increase in both natural gasoline and L.P.G. production.

JOURNAL SURVEY OF FIELD PROCESSING PLANTS

State—	No. plants	Gas cap., M.M.c.f. per day	Gallons per day: Nat. gaso. and heavier	Gallons per day: Total butane and lighter	Gallons per day: Nat. gaso. and L.P.G. reported as combined total	Gallons per day: Total all nat. gaso. and L.P.G. produced
Arkansas	8	162	103,553	113,969		217,522
California	70	1,784	2,321,263	1,032,117		3,353,380
Colorado	6	112	127,706	101,894		229,600
Illinois	6	37	75,361	240,500		315,861
Kansas	14	1,836	394,573	335,985	20,000	750,558
Kentucky	4	1,130	98,000	430,000		528,000
Louisiana	34	1,627	646,511	368,236	12,000	1,026,747
Michigan	1	10	9,000	None		9,000
Mississippi	1	22	6,500	6,500		13,000
Montana	1	65	12,000	18,000		30,000
Nebraska	3	34	15,667	34,112		49,779
New Mexico	20	1,406	805,870	722,858	222,000	1,750,728
North Dakota	1	65	25,000	110,000		135,000
Ohio	2	32	2,555	None		2,555
Oklahoma	60	1,714	844,865	1,101,751	1,036,000	2,982,616
Pennsylvania	6	86	13,858	3,000		16,858
Texas	183	10,608	5,716,379	6,586,755	4,979,000	17,282,134
Utah	1	22	800	None		800
West Virginia	32	563	176,600	157,000		333,600
Wyoming	12	311	115,280	129,187	30,000	274,467
Total U. S.	465	21,626	11,511,341	11,491,864	6,299,000	29,302,205

Here's what our symbols mean . . .

*Gas injection conducted. †Figures represent capacity, not production. ‡Combined natural gasoline and L.P.G. §Plant primarily for removing liquids from gas to prevent them dropping out in pipeline; not for commercial production of gasoline. ¶Average production based on 11 months—January through November. ‖Plant figures estimated.

ARKANSAS

Plant location (field, county, and nearest town)—	Gas cap., M.M.c.f. per day	Natural gasoline and heavier, gal. per day	Total butane and lighter, gal. per day
Arkansas Louisiana Gas Co.:			
Dorcheat-Macedonia, Columbia (Magnolia)	100	24,409	61,559
Arkla Oil Co.:			
Loe, Miller (Rodessa)*‡	11	14,000	4,000
Atlanta Gas Co.:			
Atlanta, Columbia (Magnolia)	4	5,000	6,000
Lion Oil Co.:			
Shuler, Union (El Dorado)*	30	10,000	8,000
Magnolia Petroleum Co.:			
Kenova, Union (Smackover)	1.45	5,444	810
J. R. Querbes Oil Co.:			
South, Union (El Dorado)	1	6,000	None
Shell Oil Co.:			
Magnolia, Columbia (Magnolia)	12	31,700 (26 lb. R.v.p.)	23,600
Sunray Mid-Continent Oil Corp.:			
Midway, Lafayette (Lewisville)	3	7,000 (Solvents)	10,000
Total	162	103,553	113,969

CALIFORNIA

Plant location (field, county, and nearest town)—	Gas cap., M.M.c.f. per day	Natural gasoline and heavier, gal. per day	Total butane and lighter, gal. per day
Bankline Oil Co.:			
Santa Fe Springs, Los Angeles (Santa Fe Springs)	5	20,000	2,000
Midway-Sunset, Kern (Maricopa)	10	15,000	2,000
Coline Gasoline Corp.:			
Rincon-Padre, Ventura (Ventura)	20	15,000	33,000
Continental Oil Co.:			
San Miguelito, Ventura, (Ventura)*	30	47,763	22,967
General Petroleum Corp.:			
Wilmington, Los Angeles (Wilmington)	45	81,000	None
Santa Fe Springs, Los Angeles (Santa Fe Springs)	15	40,000	None
Ventura, Ventura (Ventura)	15	19,000	None
Helm, Fresno (Burrel)	25	12,500	21,000
Brea-Olinda, Orange (Brea)		(Plant idle)	
Honolulu Oil Corp.:			
Buena Vista Hills, Kern (Buena Vista)	12	23,000	6,500
Cymric, Kern (jointly owned with Standard and Superior)	40	23,000	32,000
Inglewood Gasoline Co.:			
Potrero, Los Angeles (Inglewood)	6	5,500	None
Lomita Gasoline Co.:			
Signal Hill	60	100,000	20,000

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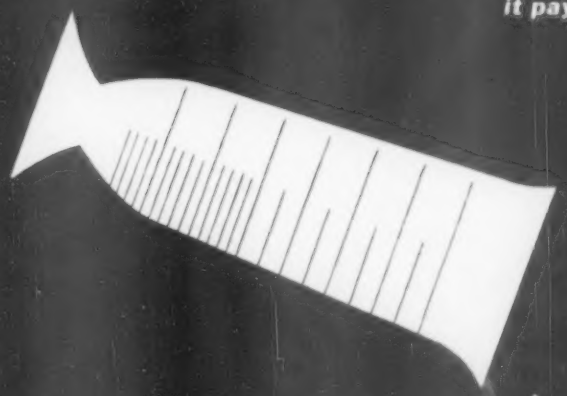

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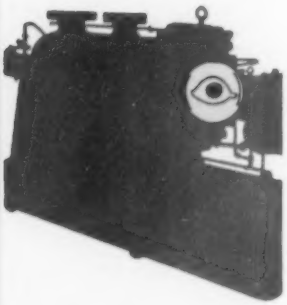

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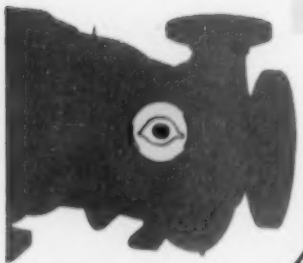

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Processing-Plant Survey

Plant location (field, county, and nearest town)—	Gas cap., M.M.c.f. per day	Natural gasoline and heavier, gal. per day	Total butane and lighter, gal. per day
P. S. Magruder, operator, Western-Huffman Gasoline Plants:			
Kettleman Hills, Kings (Avenal)	65	70,000	60,000
Kettleman Hills, Fresno (Avenal)*	50	70,000	50,000
Monterey Oil Co.:			
Huntington Beach, Orange (Huntington Beach)	12	28,000 (53 lb. R.v.p.)	None
Rice Rance Oil Co.:			
Orcutt	1	1,800	None
Richfield Oil Corp.:			
North Coles Levee, Kern (Tupman)*	160	105,000	80,000
South Cuyama, Santa Barbara (New Cuyama)*	80	82,000	53,000
Russel Ranch, San Luis Obispo (New Cuyama)*	18	34,000	23,000
East Los Angeles, Los Angeles (Los Angeles)	5	4,000	None
Shell Oil Co.:			
Brea, Orange (Brea)	17	56,000 (75 lb. R.v.p.)	None
Capitan, Santa Barbara (Santa Barbara)	0.6	1,200 (42 lb. R.v.p.)	250
Long Beach, Los Angeles (Long Beach)	5.1	36,200 (56 lb. R.v.p.)	None
Santa Maria, Santa Barbara (Santa Maria)	0.6	1,600 (45 lb. R.v.p.)	None
Ten Section, Kern (Bakersfield)	33	22,800 (22 lb. R.v.p.)	55,500
Ventura, Ventura (Ventura)	106	247,000 (55 lb. R.v.p.)	59,500
Signal Oil & Gas Co.:			
Signal Hills, Los Angeles (Long Beach)	40	55,000	15,000
Ellwood, Santa Barbara (Goleta)*	15	7,500	3,000
Huntington Beach, Orange (Huntington Beach)	50	140,000	40,000
Standard Oil Co. of California:			
Huntington Beach, Orange (Huntington Beach)	15	39,000	7,300
Inglewood, Los Angeles (Inglewood)	15	21,000	None
Murphy Coyote, Orange (La Habra)*	50	51,000	15,000
Santa Fe Springs, Los Angeles (Santa Fe Springs)	5	16,600	None
Seal Beach, Los Angeles (Seal Beach)	20	33,000	None
Torrance, Los Angeles (Torrance)	6	9,500	None
Midway, 1-C, Kern (Taft)*	35	47,000	6,800
Midway, 7-D, Kern (Taft)	8	15,000	None
Midway, 29-G, Kern (Taft)	7	9,000	None
Greeley, Kern (Bakersfield)*	25	19,000	30,000
Lost Hills, Kern (Bakersfield)	3.5	3,100	None
Mt. View, Kern (Bakersfield)	14	18,500	None
Kettleman North Dome, 11P, Kings (Avenal)*	40	38,000	None
Kettleman North Dome, 3P, Kings (Avenal)*	60	18,000	67,200
Kettleman North Dome, 33J, Fresno (Avenal)*	40	35,000	None
Northeast Coalinga, Fresno (Coalinga)	40	6,000	None
Sunray Mid-Continent Oil Co.:			
Newhall-Potrero, Los Angeles*	40	20,700	30,000
Superior Oil Co.:			
Rio Bravo, Kern (Shafter)*	30	19,000	48,000
The Texas Co.:			
Honor Rancho, Los Angeles (Castaic)*	18	11,000	14,000
Santa Fe Springs, Los Angeles (Santa Fe Springs)	5	35,000	2,100
Signal Hill, Los Angeles (Signal Hill)	30	65,000	9,000
Shiells Canyon, Ventura (Fillmore)	24	24,000	30,000
Tide Water Associated Oil Co. (3 plants):			
Ventura, Ventura (Ventura)	88	75,000	85,000
Union Oil Co. of California:			
Brea, Orange (Brea)	30	50,000	None
Richfield, Orange (Placentia)	5	9,000	None
Santa Fe Springs, Los Angeles (Santa Fe Springs)	7	45,000	None
Dominguez, Los Angeles (Compton)	18	45,000	None
Rosecrans, Los Angeles (Los Angeles)	12	20,000	None
Playa del Rey, Los Angeles (Venice)	4	6,000	None
Sansinena, Los Angeles (Whittier)	7	10,000	None
Orcutt, Santa Barbara (Orcutt)	6	18,000	7,000
Santa Maria, Santa Barbara (Santa Maria)	25	35,000	30,000
Coalinga Nose, Fresno (Coalinga)*	30	30,000	40,000
Belgian Anticline, Kern (Taft)	8	6,000	None
Del Valle, Ventura (Saugus)	32	20,000	32,000
Grimes Canyon, Ventura (Santa Paula)	3	2,000	None
West Mountain, Ventura (Santa Paula)	2	2,000	None
West Coast Refining Co.:			
Richfield, Orange (Placentia)	35	31,000	None
Total	1,784	2,321,263	1,032,117
COLORADO			
The California Co.:			
Rangely, Rio Blanco (Craige)*	48	75,000	36,000
Continental Oil Co.:			
Little Beaver, Washington (Brush)	10	16,883	23,894
Kansas-Nebraska Natural Gas Co.:			
Julesburg Basin, Logan (Sterling)	4.1	5,423	None
Mountain Fuel Supply Co.:			
Hiawatha, Moffat	15	1,000	None
Powder Wash, Moffat	15	3,400	None
Pure Oil Co.:			
Adena, Morgan	20	26,000	42,000
Total	112	127,706	101,894
ILLINOIS			
Brenneman & MacDonell:			
Sarah Dee, Crawford (Oblong)	0.25	60	
Frank Condrey, Crawford (Oblong)	0.05	1	
Carter Oil Co.:			
Loudon, Fayette (St. Elmo)*	14	7,000	17,500
The Texas Co.:			
Hoodville, Hamilton (McLeansboro)	7	†14,000	†63,000
Salem, Marion (Salem)	10	†44,300	†124,000
Warren Petroleum Corp.:			
Crossville	6	10,000	36,000
Total	37	75,361	240,500
KANSAS			
Cabot Carbon Co.:			
Sturgis E. Purdy, Texas (Elkhart)	1.5	250	None
Cities Service Oil Co. (Del.):			
Pampa-Hugoton, Sedgwick (Wichita)	183	72,000	32,000
Burrton-Stone, Reno (Burrton)	5	11,000	11,000
Colorado Interstate Gas Co.:			
Hugoton, Kearney (Lakin)	215	40,000	None
Dunn-Mar Oil & Gas Co.:			
Otis	10	4,800	400
Hugoton Production Co.:			
Hugoton, Grant (Ulysses)	90	18,000	34,000
Kansas-Nebraska Natural Gas Co., Inc. (formerly Deerfield Petroleum Co.):			
Hugoton, Kearney (Deerfield)	125	10,370	3,270

Processing-Plant Survey

Plant location (field, county, and nearest town)—	Gas cap., M.M.c.f. per day	Natural gasoline and heavier, gal. per day	Total butane and lighter, gal. per day
Kansas Power & Light Co.:			
Barber (Medicine Lodge)	48	†15,000	None
Magnolia Petroleum Co.:			
Hickok, Grant (Ulysses)	134	21,123	22,360
Northern Natural Gas Co.:			
Hugoton, Seward (Sublette)	265	43,395	None
Hugoton, Finney (Holcomb)	185	9,563	None
Panhandle Eastern Pipe Line Co.:			
Hugoton, Seward (Liberal)	240	58,572	33,055
Skelly Oil Co.:			
Kingman*	7	‡20,000	
Stanolind Oil & Gas Co.:			
Hugoton, Grant-Stanton-Morton-Stevens (Ulysses)	325	86,000	197,000
The Texas Co.:			
Atlanta, Cowley (Burden)*	2.5	†4,500	†2,900
Total	1,836	(See state summary table)	
KENTUCKY			
Tennessee Gas Transmission Co.:			
Dwale, Floyd	950	50,000 (Stripping operation)	375,000
Kentucky West Virginia Gas Co.:			
Dwale, Floyd	40	8,000	None
United Fuel Gas Co.:			
Boyd	100	†25,000	†30,000
Martin	40	†15,000	†25,000
Total	1,130	98,000	430,000
LOUISIANA			
Amerada Petroleum Corp.:			
Lake Chicot, St. Martin (Baton Rouge)	2.5	2,100 (34 lb. R.v.p.)	None
Anchor Gasoline Corp.:			
Avoyelles, Eola	30.5	13,300	12,200
Evangeline, Easton	14	7,700	6,200
Acadia, Eunice	27	5,000	13,000
Anse LaButte Gasoline Corp.:			
Anse LaButte, St. Martin		‡12,000	
Arkansas Fuel Oil Corp.:			
Homer, Claiborne (Homer)*	0.6	3,029	None
Arkansas Louisiana Gas Co.:			
Bistineau-Ada, Webster (Heflin)	60	None	8,423
Ruston, Lincoln (Ruston)	60	12,007	12,927
Rodessa, Caddo (Rodessa)	5	4,913	112
Shreveport, Caddo (Shreveport)	2	4,450	251
Sligo, Bossier (Haughton)	60	None	6,116
Atlantic Refining Co.:			
Neale, Beuregard (Merryville)*	22	10,800	8,150
The California Co.:			
Hico-Knowles, Lincoln (Ruston)	70	None	35,000
Claiborne Gasoline Co.:			
Lisbon, Claiborne (Shreveport)	160	130,000	30,000
Continental Oil Co.:			
Gillis, Calcasieu (Lake Charles)	90	86,954	None
Ville Platte, Evangeline (Ville Platte)*	120	57,215	30,837
Drew Cornell, Inc.:			
Bayou Mallet, Acadia (Eunice)	12	4,000	1,400
Gulf Oil Corp.-Gulf Refining Co.:			
Homer, Claiborne (Homer)*	5	6,000	None
Haynesville Operators Committee:			
Haynesville, Claiborne (Haynesville)*	21	25,000	12,000
Humble Oil & Refining Co.:			
St. Landry (Opelousas)	174	†59,340	†62,360
Jefferson Lake Sulphur Co.:			
Bayou Sale, St. Mary	40	(Not reported)	
Magnolia Petroleum Co.:			
Mamou, Evangeline (Mamou)	7	8,954	5,474
Hurricane Creek, Beauregard (Longville)	4	8,626	2,526
Mississippi River Fuel Corp.:			
Morehouse (Monroe)§	300	5,500	None
Ohio Oil Co.:			
Haynesville, Claiborne (Haynesville)	10	4,223	1,260
Shell Oil Co.:			
Iowa, Calcasieu (Iowa)	26	11,400 (26 lb. R.v.p.)	None
Sun Oil Co.:			
Delhi, Richland (Delhi)	17	25,000	50,000
The Texas Co.:			
Lafitte, Jefferson (Lafitte)	22	†14,000	None
Paradis, St. Charles (Paradis)	115	†36,500	†59,000
Union Oil & Gas Corp. of Louisiana (formerly Union Sulphur & Oil Corp.):			
South Lewisburg, Acadia (Church Point)	10	8,500	None
Welsh, Jeff Davis (Lacassine)	10	4,000	None
United Gas Pipe Line Co.:			
Sligo-Bisteneau, Bossier-Webster (Haughton)	60	†18,000	†4,000
Rodessa, Caddo (Vivian)	50	†50,000	†4,000
Sugar Creek, Claiborne (Arcadia)	30	†20,000	†3,000
Total	1,627	(See state summary table)	
MICHIGAN			
Dow Chemical Co.:			
Beaver Creek, Crawford (Grayling)	10	9,000	None
MISSISSIPPI			
The California Co.:			
Brookhaven, Lincoln (Brookhaven)*	22	6,500	6,500
MONTANA			
Union Oil Co. of California:			
Cut Bank, Glacier (Cut Bank)*	65	12,000	18,000
NEBRASKA			
Kimball Gas Products Co.:			
Long-Enders-Dietz, Kimball	7.5	(Not reported)	
Ohio Oil Co.:			
Huntsman, Cheyenne (Sidney)	13	8,962	20,216
West Sidney, Cheyenne (Sidney)	13	6,705	13,896
Total	34	15,667	34,112
NEW MEXICO			
Atlantic Refining Co.:			
Denton, Lea (Lovington)	22	31,500	101,000
El Paso Natural Gas Co.:			
Jal No. 1 plant, Lea (Jal)*	100	32,000	10,500
Jal No. 2 plant, Lea (Jal)	50	67,699	73,166
Jal No. 3 plant, Lea (Jal)	50	(Remote absorbers only. Rich oil piped to Jal No. 2)	
Jal No. 4 plant, Lea (Jal)	183	86,000	56,080
Blanco, San Juan (Farmington)	70	25,618	28,726
Blanco, San Juan (Bloomfield)	269	(Absorption only. Product piped to Wingate fractionating plant.)	
Wingate, McKinley (Gallup)	None	128,640	148,752
Frontier Natural Gasoline Co.:			
Grayburg-Jackson, Eddy (Loco Hills)	7	6,000	15,000
Gulf Oil Corp.:			
Various, Lea (Eunice)	55	34,115	86,217
Maljamar Co-op Repressuring Agreement:			
Lea*	9.8	7,094	18,715
Permian Basin Pipeline Co.:			
Lea, Lea (Hobbs)	150	41,024	49,193
Phillips Petroleum Co.:			
Eunice, Lea (Oil Center)	140	††112,000	
Hobbs-Vacuum, Lea (Hobbs)	42	††85,000	
Skelly Oil Co.:			
Lea	128	†285,000	
Southern Union Gas Co.:			
Kutz Canyon, San Juan (Bloomfield)	20	¶7,680	¶16,509
Valley Gas Corp.:			
Loco Hills, Eddy (Artesia)*	6	5,000	12,000
Anderson Ranch, Lea	3.6	‡25,000	
Warren Petroleum Co.:			
Plant 18, Monument	64	27,500	39,500
Plant 46, Lovington	37	21,000	67,500
Total	1,406	(See state summary table)	

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3. ISO-PLUS Thermal Processing

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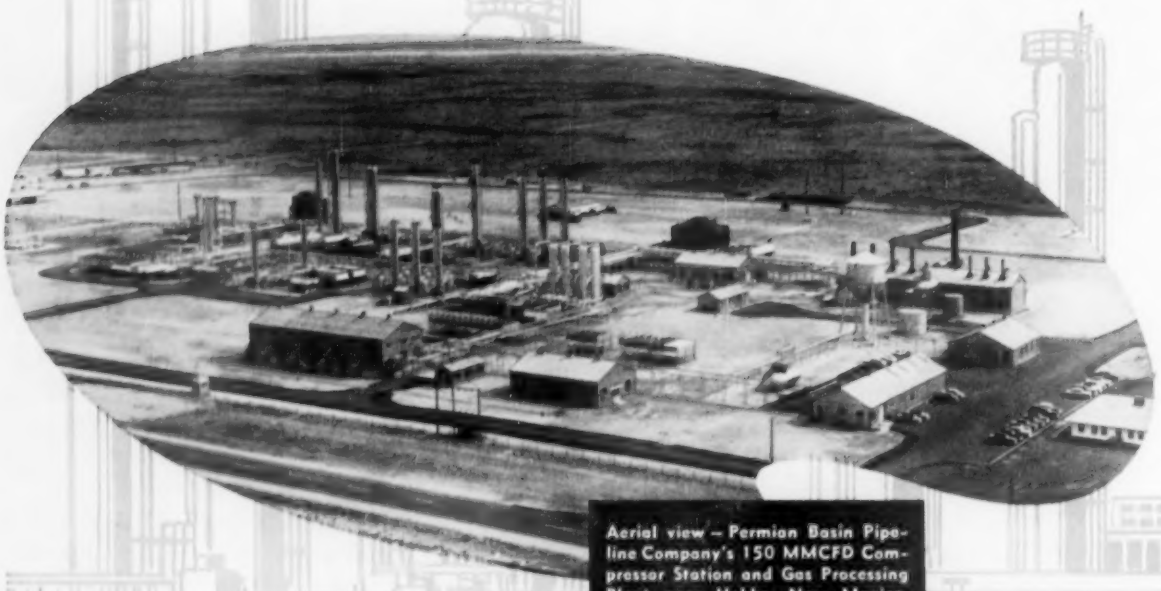

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Processing-Plant Survey

NORTH DAKOTA

Plant location (field, county, and nearest town)—	Gas cap., M.M.c.f. per day	Natural gasoline and heavier, gal. per day	Total butane and lighter, gal. per day
Signal Oil & Gas Co.:			
Tioga-Beaver Lodge, Williams (Tioga)	65	25,000	110,000

OHIO

East Ohio Gas Co.:			
Hughland Heights Cuyahoga (Cleveland)	17	55	None
Ohio Fuel Gas Co.:			
York Plant (Medina)	15	2,500	None
Total	32	2,555	None

OKLAHOMA

Apache Gasoline Co.:			
West Brook, Carter (Ardmore)	4	5,000	7,500
Boswell-Frates Co.:			
Sporn, Lincoln (Tyron)	2	2,000	None
Norfolk, Payne (Cushing)	1.2	1,000	None
Edna, Creek (Edna)	2	1,000	None
Carter Oil Co.:			
Fitts, Pontotoc (Fittstown)	9	11,500	20,000
Seminole, Seminole (Seminole)*	7	17,000	29,700
Cromwell, Seminole (Cromwell)	6.5	11,500	11,700
The Chicago Corp.:			
Witcher plant, Champlin Ref. Co. (Okla. City)	25	14,700	29,400
Cities Service Oil Co. (Del.):			
Oklahoma City, Okla. (Okla. City)*	7	7,000	2,000
Hugoton, Texas (Guymon	160	12,000	None
Hugoton, Kay (Blackwell)	174	54,000	107,000
Dorchester Corp.:			
Hugoton, Texas (Hooker)	100	18,000	68,000
Frame Natural Gasoline Co.:			
Osage, Cleveland		2,000	None
Gasoline Plant Management (Operator of Lucien Unit Plant):			
Noble (Perry)	8	8,000	16,000
Garber, Inc. (Sterling Gasoline Plant):			
Spring Valley, Garfield (Garber)	15	12,000	6,000
Grimes Gasoline Co.:			
Weiumka, Hughes (Weiumka)	15	4,000	2,000
Grimes & Grimes:			
Weleetka, Okfuskee (Weleetka)	15	8,000	2,500
Okemah, Okfuskee (Okemah)	1	1,000	None
Otha H. Grimes:			
Pauls Valley, Garvin (Pauls Valley)	5	5,000	6,000
Gulf Oil Corp.:			
Altus pool, Jackson (Altus)	1.6	450	None
Highway Gasoline Co.:			
Middle Peck, Lincoln (Stroud)	4	7,500	7,500
Hugoton Plains Gas & Oil Co.:			
Hugoton, Tex. (Tryon)	120	14,000	31,533
Keener Oil Co.:			
(Butler)	35	1,000	12,000
Kerr-McGee Oil Industries, Inc.:			
Fitts, Pontotoc (Fittstown)	10	4,000	4,000
Stroud, Creek (Milfay)	15	3,500	8,500
Happy Valley, Lincoln (Cushing)	10	2,000	5,500
Lone Star Gas Co.:			
Katie plant, Garvin (Elmore City)	25	20,000	None
Magnolia Petroleum Co.:			
Graham, Carter (Fox)	18	17,970	8,476
Sholem-Alechem, Stephens (Countyline)	43	34,486	54,177
Moran Gasoline Co.:			
Kendrick, Lincoln	9	8,000	17,000
Neal Gasoline Corp.:			
Osage	4	4,800	None
Patton & Swab:			
Edmond, Oklahoma (Edmond)	25	18,000	7,000
Phillips Petroleum Co.:			
Burbank, Osage (Shidler)	15	†142,000	
Burbank, Osage (Fairfax)	8	†32,000	
Edmond, Oklahoma (Edmond)	130	††190,000	
Oklahoma City, Oklahoma (Oklahoma City)	16	†155,000	
Wewoka, Seminole (Wewoka)	6	†127,000	
Edmond, Oklahoma (Edmond)	65	†175,000	
Pure Oil Co.:			
Creek (Sapulpa)*	4	5,400	None
Shell Oil Co. (Barco plant, Harry Ells, Inc., Operator):			
Carter (Healdton)*	2.5	4,000	5,000
Shell Oil Co.:			
Hewitt, Carter (Wilson)	6.1	10,600 (18 lb. R.v.p.)	15,800
Signal Oil & Gas Co.:			
Fox-Milroy, Carter (Ardmore)	55	40,000	60,000
Sinclair Oil & Gas Co.:			
Creek (Drumright)		††155,000	
Garfield (Covington)		††100,000	
Plant 12, Seminole (Seminole)		†80,000	None
Plant 13, Seminole (Seminole)		††210,000	
Pottawatomie (St. Louis)		†30,000	None
Skelly Oil Co.:			
Osage*	9	†30,000	
Velma, Stephens	70	††120,000	
Sohio Petroleum Co.:			
W. Edmond, Kingfisher (Edmond)	10	4,500	2,500
Eola, Garvin (Elmore)	10	6,000	13,000
Sokla Gasoline Co.:			
Fox, Carter (Fox)	5	4,159	4,865
Sunray Mid-Continent Oil Co.:			
Drumright, Sawyer No. 3, Creek (Drumright)*	2	5,400	3,400
Cromwell, No. 7, Seminole (Cromwell)*	4	9,200	6,700
Moore, No. 19, Cleveland (Moore)	10	12,000	15,000
The Texas Co.:			
Davenport, Lincoln (Davenport)	15	†14,700	†25,000
Warren Petroleum Corp.:			
Plant No. 15 (Maud)	8	9,000	13,000
Plant No. 22 (Madill)	9	8,500	16,000
Plant No. 33 (Maysville)*	340	250,000	420,000
Plant No. 40 (Ringwood)	18	21,000	38,000
Total	1,714	(see state summary table)	

PENNSYLVANIA

Equitable Gas Co.:			
Greene (Rogersville)	25	2,758	None
Mars Co.:			
Strong, Venango (Van)		1,300	3,000
Hampton, Venango (Oil City)		1,200	None
Kane, Elk (Kane)		600	None
Pennsylvania Gas Co.:			
Roystone, Sheffield (Warren)	11	3,000	None
Peoples Natural Gas Co.:			
Brave, Greene (Waynesburg)	50	5,000	None
Total	86	13,858	3,000

TEXAS

Amarillo Oil Co.:			
W. Panhandle, Potter, Fain plant	80	20,000	15,000
W. Panhandle, Potter, Turkey Creek plant	80	20,000	15,000
Arkansas Fuel Oil Corp.:			
E. Texas, Gregg (Greggton)	10	23,322	57,678
W. Carthage, Panola (Carthage)	100	36,957 (Motor fuel)	29,097
Arkansas Louisiana Gas Co.:			
E. Carthage, Panola (Carthage)	40	None	14,449
Jefferson, Marion (Jefferson)	31	None	9,088
Rodessa, Marion (Smithland)	12	4,504 (Reprocessed at Jefferson plant)	None
Waskom, Harrison (Waskom)	145	None	43,573
Atlantic Refining Co.:			
Block 31, Crane (Crane)*	39	16,500	None
Barnhart Hydrocarbon Corp.:			
Barnhart, Reagan (Big Lake)	25	12,100	42,300

Processing-Plant Survey

Plant location (field, county, and nearest town)—	Gas cap., M.M.c.f. per day	Natural gasoline and heavier, gal. per day	Total butane and lighter, gal. per day
Black Hawk Gasoline Corp.:			
Alco-Graham, Jack (Graham)	4.5	5,000	2,600
Bowie Gasoline Co.:			
Montague (Bowie)	21	15,000	55,000
Cabot Carbon Co.:			
N. & S. Ward, Ward (Monahans)*	30	17,870	6,540
Keystone-Kermit, Winkler (Kermit)	30	25,470	12,475
Carthage Co.:			
Carthage, Panola (Carthage)	475	400,000 (Motor fuel and heavier)	225,000
Caska Corp.:			
Quitman, Wood (Quitman)	4	7,000	11,000
The Chicago Corp.:			
Feazel-Kinsey, Panola (Carthage)	210	147,000	105,000
Cities Service Oil Co.:			
Pampa, Gray (Pampa)*	30	45,000	20,000
Chico, Wise (Chico)	15	13,000	25,000
W. Seminole, Gaines (Seminole)	15	25,000	50,000
Colorado Interstate Gas Co.:			
W. Panhandle, Moore (Fourway)	150	85,000	15,000
W. Panhandle, Moore (Bivins)	165	55,000	None
Coltexo Corp.:			
Panhandle, Gray (Pampa)	60	35,000	None
Continental Oil Co.:			
Rincon, Starr (Rio Grande City)*	20	25,718	7,010
K.M.A., Wichita (Electra)*	19	63,929	None
Todd Ranch, Crockett (Big Lake)	9.3	10,671	27,710
Dorchester Corp.:			
Carson (White Deer)	100	30,000	85,000
El Paso Natural Gas Co.:			
Sealy-Smith, Ward (Monahans)	16	16,536	25,200
Midkiff plant, Reagan (Midland)	166	208,033	343,687
Empire Oil of Texas:			
S. Cowden, Ector (Odessa)	4	(Not reported)	
Goliad Corp.:			
Clayton-Kittie, Live Oak (Three Rivers)	105	29,000	70,000
Hagist Ranch, Duval (Freer)	45	7,000	30,000
Wilcox plant, Lavaca (Sheridan)	200	52,000	100,000
Graridge Corp.:			
Plant No. 1, Shackelford (Breckenridge)	10	4,000	3,000
Plant No. 2, Eastland (Eastland)	15	6,500	7,000
Plant No. 3, Young (Graham)	3	4,000	3,000
	(Actual amount being processed)		
Otha H. Grimes:			
Ringgold, Clay (Ringgold)	2	2,500	2,500
Eskota, Fisher (Trent)	1.5	2,500	2,000
Gulf Oil Corp.:			
Sand Hills-Univ. Waddell, Crane (Crane)	45	30,641	53,919
North Ward Estes, Ward (Wickett)	25	19,070	None
Pace-Fry-Sueise, Runnels (Wingate)	5	4,071	5,707
Gulf Oil Corp.-Gulf Refining Co.:			
E. Texas, Rusk (Overton)	5	6,000	11,000
E. Texas, Gregg (Kilgore)	16	40,000	60,000
Frank C. Henderson Trust No. 2:			
W. Panhandle, Hutchinson (Sanford)	50	26,000	None
Honolulu Oil Corp.:			
Ropes, Hockley (owned jointly with Signal)	2	6,500	13,500
White Flat, Nolan (owned jointly with B. G. Byars, A. G. Hill, N. B. Hunt, L. C. Johnston, B. W. Payne)	6.5	17,000	31,000
J. M. Huber Corp.:			
Panhandle, Hutchinson (Borger)	70	37,184	None
Humble Oil & Refining Co.:			
Anahuac, Chambers (Monroe City)	100	††46,200	
Clear Lake, Harris (Genoa)	125	†30,450	†36,540
Conroe, Montgomery (Conroe)	29	†70,560	†30,240
E. Texas, Rusk (Overton)	23	†67,680	†206,070
Flour Bluff, Nueces (Corpus Christi)	17	†7,980	None
Heyser, Calhoun (Bloomington)	18	†8,400	None
Jourdanton, Atascosa (Jourdanton)	26	†31,290	†18,270
Pickton, Hopkins (Pickton)*	49	†30,610	†66,130
Tomball, Harris (Tomball)	46	††37,800	
Neches, Cherokee (Jacksonville)	9.5	††65,000	
Tom O'Connor, Refugio (Refugio)	125	†19,320	†41,160
Ibex Co.:			
Eastland, Eastland (Eastland)	10	6,000	6,000
Ibex, Shackleford (Albany)	10	3,200	3,500
Kerr-McGee Oil Industries, Inc.:			
Gray (Pampa)	30	30,000	28,000
Moore (Cactus)	58	20,000	40,000
Lion Oil Co.:			
Diamond M-Sharon Ridge, Scurry (Snyder)	52	70,000	210,000
Lone Star Gas Co.:			
Trinidad plant, Henderson (Trinidad)	240	40,000	40,000
Springtown plant, Parker (Springtown)	125	30,000	70,000
Gordon plant, Palo Pinto (Gordon)	75	25,000	20,000
Pueblo plant, Eastland (Cisco)	40	7,000	None
Lone Star Producing Co.:			
McElroy-Wilshire plant, Upton (Crane)	15	10,000	37,500
Fort Chadbourne, Runnels (Bronte)*	30	15,000	45,000
RFC plant, Eastland (Ranger)	None	40,000	35,000
Plant 108, Eastland (Ranger)	12	60,000	None
Brooks plant, Stephens (Breckenridge)	6	25,000	None
Magnolia Petroleum Co.:			
Burkburnett, Wichita (Burkburnett)	1.4	8,917	4,478
Desdemona, Eastland (Desdemona)	1.3	6,488	2,993
Electra, Wilbarger (Electra)	0.6	3,691	1,889
Pegasus, Midland (Midland)	60	65,997	116,358
Vanderbilt, Jackson (Vanderbilt)	80	34,351	8,665
Sabine, Gregg (Kilgore)	8	22,223	45,500
Kenava, Union (Smackover)	1.5	5,444	810
Kermit, Winkler (Kermit)	9.2	4,989	4,739
Matagorda Corp.:			
Markham, Matagorda (Bay City)	Frac	85,000	None
Nash Gasoline Co. (Closed 2-23-56):			
James Pool, Young (Graham)	3	2,500	2,500
South Bend, Young (Graham)	5	3,500	2,000
Natural Gas Pipe Line Co. of America:			
Panhandle, Hutchinson (Fritch)	192	84,662	10,490
Panhandle, Moore (Stinnett)	180	84,657	9,283
Natural Gasoline Corp.:			
Smith (Hawkins)	22	28,000	92,000
Odessa Natural Gasoline Co.:			
S. Cowden-Foster, Ector (Odessa)	45	50,000	60,000
Ohio Oil Co.:			
North Markham-N. Bay City, Matagorda (Bay City)*	210	None	65,137
Parade Co.:			
E. Texas, Rusk (Overton)	12	42,642	60,110
Pecos Co.:			
Spraberry (Midland)	33	20,000	55,000
Santa Rosa, Pecos (Grand Falls)	35	2,000	9,000

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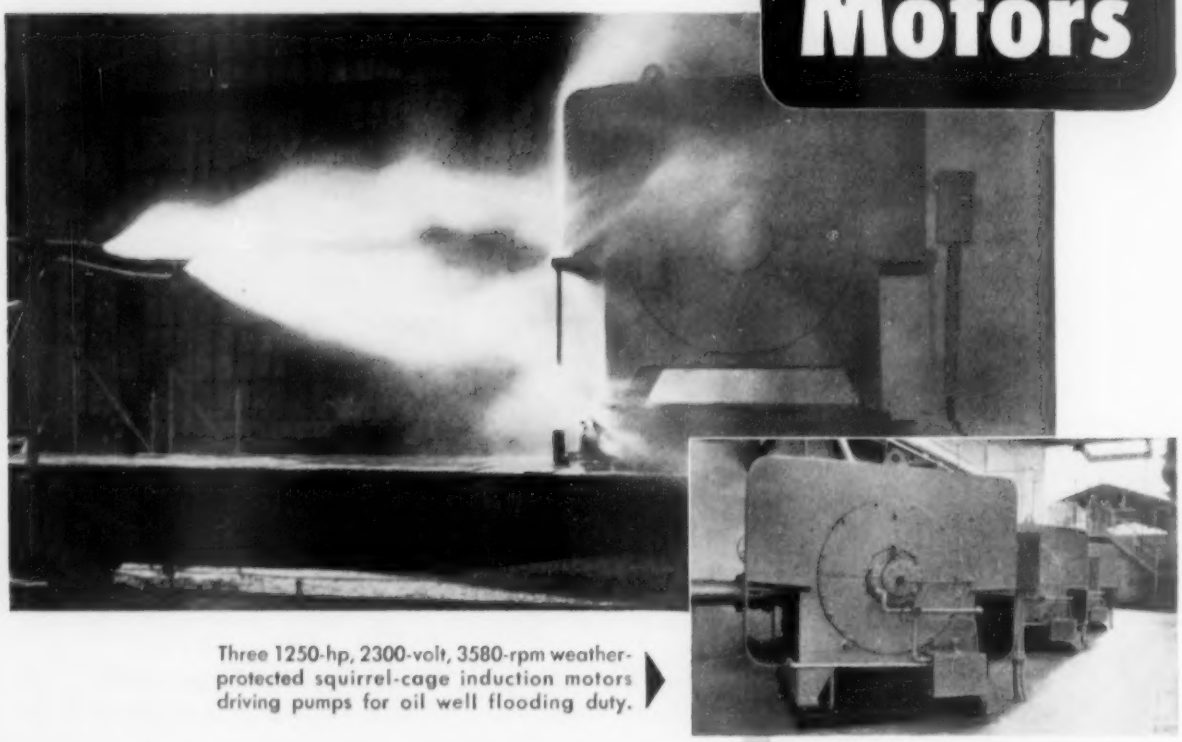

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ALLIS-CHALMERS

Processing-Plant Survey

Plant location (field, county, and nearest town)—	Gas cap., M.M.c.f. per day	Natural gasoline and heavier, gal. per day	Total butane and lighter, gal. per day
Phillips Petroleum Co.:			
Chocolate Bayou, Brazoria (Alvin)	360	††300,000	
W. Panhandle, Moore (Phillips)	210	††145,000	
Gray plant, E. Panhandle, Gray (Pampa)	80	††107,000	
Lefors plant, E. Panhandle, Gray (Pampa)	45	††50,000	
North plant, E. Panhandle, Gray (Pampa)	10	††43,000	
Pampa plant, E. Panhandle, Gray (Pampa)	25	††65,000	
Canadian plant, W. Panhandle, Hutchinson (Phillips)	20	††75,000	
Pantex plant, W. Panhandle, Hutchinson (Phillips)	50	††57,000	
Rock Creek plant, W. Panhandle, Hutchinson (Phillips)	240	††203,000	
Sanford plant, W. Panhandle, Hutchinson (Phillips)	100	††132,000	
Sneed plant, W. Panhandle, Moore (Phillips)	260	††167,000	
Hansford plant, W. Panhandle, Hansford (Guymon, Okla.)	140	††106,000	
Sherman plant, W. Panhandle, Hansford (Guymon, Okla.)	380	††220,000	
McElroy, Crane (Crane)	50	††125,000	
Goldsmith, Ector (Goldsmith)*	250	††600,000	
Fullerton, Andrews (Andrews)*	75	††225,000	
Harper-Penwell-Jordan, Ector (Penwell)	25	††85,000	
Seminole, Gaines (Seminole)	33	††47,000	
Tex Harvey, Midland (Spraberry)	62	††200,000	
Pembrook, Upton (Midkiff)	40	††130,000	
Plymouth Oil Co.:			
Susan Peak, Tom Green (San Angelo)*	3	2,400	None
Pure Oil Co.:			
Dollarhide, Andrews	65	105,000	122,000
Van, Van Zandt (Van)	8	‡40,000 (Butane plus)	17,000 (Propane)
Reef Fields Gasoline Corp.:			
E. Vealmoor, Borden-Howard (Big Spring)	38	60,000	195,000
Renwar Oil Corp.:			
Mustang Island, Nueces (Corpus Christi)	50	35,000	None
Sid Richardson Gasoline Co.:			
Keystone, Winkler (Kermit)	150	75,000	100,000
Rowan & Hope:			
Strawn Reef, Nolan (Sweetwater)	5	4,000	1,000
Runnels Gas Products Corp.:			
Cree Sykes-Goldsboro, Runnels (Crews)*	28	25,000	65,000
Rycade Oil Co. (was C. V. Lyman):			
Emperor, Winkler (Wink)	15	6,000	6,000
Shamrock Oil & Gas Corp.:			
Panhandle, Moore (Sunray)	400	128,000	302,400
Shell Oil Co.:			
TXL, Ector (Notrees)	69	83,000 (26 lb. R.v.p.)	114,000
Wasson, Yoakum (Denver City)	120	173,000 (42 lb. R.v.p.)	101,000
Panhandle, Carson (Skellytown)	14	27,300 (60 lb. R.v.p.)	None
Provident City, Lavaca (Sheridon)	65	70,400	14,500
Sinclair Oil & Gas Co.:			
E. Texas, Gregg (Longview)		††225,000	
E. Texas, Rusk-Smith (Troup)		††100,000	
San Patricio (Taft)		††30,000	
Rusk (Price)		††130,000	
Nolan (Sweetwater)		††18,000	
Skelly Oil Co.:			
Hutchinson, Carson-Gray*	83	‡315,000	
Southern Minerals Corp.:			
Stratton plant, Nueces (Bishop)	50	18,000	16,000
Saxet plant, Nueces (Corpus Christi)	18	9,000	2,000
Southern Production Co.:			
Pledger, Brazoria (West Columbia)	190	85,000	95,000
Standard Oil Co. of Texas:			
Sivells, Cooke (Gainesville)	5	8,000	8,000
Kelly-Snyder, Scurry (Snyder)	30	40,000	90,000
Stanolind Oil & Gas Co.:			
Luby, Petronilla-Nueces (Bishop)*	37	34,000	21,000
N. Cowden, Andrews-Ector (Odessa)*	55	71,500	93,500
Burnell-N. Pettus, Karnes-Bee-Goliad (Pettus)*	166	168,000	119,000
S. Fullerton, Andrews (Andrews)*	48	63,000	271,000
Slaughter, Cochran-Terry (Sundown)	110	121,000	175,000
Levelland, Cochran-Hockley (Levelland)*	36	62,000	72,000
Hastings, Brazoria-Galveston (Alvin)	53	28,000	32,000
Three Bar, Andrews (Kermit)*	18	26,000	65,000
Midland Farms, Andrews (Andrews)*	10	70,500	None
Stonewall Gas Products Co., Inc.:			
Katz, Stonewall (Knox City)	14	20,000	50,000
Sun Oil Co.:			
Jameson, Coke (Colorado City)*	50	40,000	50,000
South Lake, Trammel, Nolan Co.	3	6,000	None
Sun, Starr (Delmita)	50	45,000	50,000
Sunray Mid-Continent Oil Co.:			
Kelly-Snyder, Scurry (Snyder)	75	119,000	303,000
Redfish Bay-Mustang Island, San Patricio	140	23,600	88,000
Tennessee Gas Transmission Co.:			
Eagle Lake, Colorado (Eagle Lake)	100	21,000	53,500
Agua Dulce, Nueces (Banquette)	100	38,000	45,000
Holliday, Archer (Wichita Falls)*	2.5	3,000	None
The Texas Co.:			
Electra, Wichita (Electra)	22	†10,000	†13,000
Fuller, Scurry (Snyder)*	25	†50,000	†85,500
Texas Gas Corp.:			
(Winnie)	200	168,000 (Motor fuel)	80,000
Texas Natural Gasoline Corp. & Subsidiaries:			
Wimberly plant (Tye)		††100,000	
Walnut Bend plant (Gainesville)		††40,000	
Sandusky plant (Whitesboro)		††75,000	
Benedum plant (Rankin)		††175,000	
Pembrook plant (Midkiff)		††100,000	
Weiner-Floyd (Midland)		††100,000	
Perkins plant (Silver)		††300,000	
Texas Pacific Coal & Oil Co.:			
Caddo, Stephens	6	6,896	5,752
Pardue-Toler, Fisher	5	3,156	7,708
Tide Water Associated Oil Co. (Southern Div.):			
S. Sinton, San Patricio (Sinton)*	2.9	1,600	None
West Bernard, Wharton (East Bernard)	32	22,500	7,300
Yoward, Bee (Mineral)*	4	7,700	None
United Gas Pipe Line Co.:			
Agua Dulce, Nueces (Banquette)	30	†45,000	†4,000
Carthage, Panola (Carthage)	220	†304,000	†96,000
Coy City, Karnes (Karnes City)	10	†35,000	†15,000
W. T. Waggoner Estate:			
Wilbarger (Vernon)	2	3,200	700
Warren Petroleum Corp.:			
Plant 20, Fairbanks	35	15,000	8,000
Plant 27, Holliday*	17	30,000	72,000
Plant 28, McLean*	28	36,000	20,000
Plant 30, Breckenridge*	9.5	20,000	18,000
Plant 31, Gladewater	10	24,000	102,000
Plant 47, Greggton	10	23,000	82,000

Processing-Plant Survey

Plant location (field, county, and nearest town)—	Gas cap., M.M.c.f. per day	Natural gasoline and heavier, gal. per day	Total butane and lighter, gal. per day
Waskom Natural Gas Corp.:			
Waskom, Harrison	55	30,000	12,000
West Gasoline Co.:			
Hull, Liberty (Hull)*	20	†20,000	†15,000
D. E. & R. J. Whelan:			
Whelan, Harrison (Marshall)	15	7,500	None
Woodlawn Processing Corp.:			
Woodlawn, Harrison (Marshall)	60	80,000 (Motor fuel and heavier)	70,000
Total	10,608	(See state summary table)	

UTAH

Mountain Fuel Supply Co.:			
Clay Basin, Daggett	22	800	None

WEST VIRGINIA

Hope Natural Gas Co.:			
Hastings, Wetzel (New Martinsville)	250	40,000	75,000
Kennedy, Lewis (Weston)	25	8,400	None
Owens Libby-Owens Gas Department:			
Charleston	25	10,000	8,000
Pure Oil Co.:			
Kanawha (Cabin Creek)	3	3,600	None
South Penn Natural Gas Co.:			
Marion (Mannington)		800	None
Lewis (Camden)		800	None
Clay (Newton)		2,500	None
Roane (Clover)		1,200	None
Monongalia (Fairview)		3,000	None
Ritchie (Brohard)		2,600	None
Harrison (Wolf Summit)		3,500	None
Marion (Mannington)		1,200	None
Wetzel (Smithfield)		3,000	None
Tyler (West Union)		500	None
Kanawha (Blue Creek)		500	None
Wetzel (Pine Grove)		3,500	None
Roane (Walton)		1,200	None
Harrison (Shinnston)		500	None
Tyler (West Union)		500	None
Tyler (West Union)		3,000	None
Tyler (West Union)		500	None
Tyler (West Union)		1,000	None
United Fuel Gas Co.:			
Cabell	40	†10,000	†8,000
Jackson	50	†20,000	†10,000
Lincoln	40	†12,000	†28,000
Kanawha	85	†20,000	†20,000
Kanawha	35	†12,000	†8,000
Kanawha	10	†3,500	None
Total	563	176,600	157,000

WYOMING

Continental Oil Co.:			
Lance Creek, Niobrara (Lance Creek)*	28	8,849	5,108
Sussex, Johnson (Lincoln)*	15	(Not reported)	
Greater Clareton Producers:			
Clareton, Weston (Newcastle)	23	(Not reported)	
Mountain Fuel Supply Co.:			
Church Buttes (Uinta)	100	3,490	None
Mountain Valley Oil Co. (was Black Thunder Oil, Inc.):			
Clareton, Weston (Newcastle)	5	‡10,000	
Northern Utilities Co.:			
Sand Draw, Fremont (Riverton)	50	5,000	None
Ohio Oil Co.:			
McFadden, Carbon (Rock River)*	5	941	3,079
Pure Oil Co.:			
Worland, Washakie	42	17,000	40,000
Sinclair Oil & Gas Co.:			
Sweetwater, Barroil		†12,000	None
Stanolind Oil & Gas Co.:			
Elk Basin, Park (Elk Basin)*	12	17,000	39,000
Salt Creek, Natrona (Midwest)*	25	51,000	42,000
Tri-Co Gas Co.:			
Clareton	6	‡‡20,000	
Total	311	(See state summary table)	

Louisiana and Oklahoma Lead Cycling-Plant Gains

PRODUCTION of liquefied petroleum gas in cycling plants showed the greatest increase in Louisiana and Oklahoma during 1955. Louisiana also registered the greatest jump in production of natural gasoline, with Oklahoma and Texas next. Louisiana's increase in production is accounted for primarily by two new plants. One is Gulf Oil Corp.-Gulf Refining Co.'s plant at Krotz Springs; the other is Sunray Mid-Continent Oil Co.'s plant at Church Point.

CYCLING PLANTS

State—	No. of plants	Gas cap., M.M.c.f. per day	Gallons per day: Nat. gasoline and heavier	Gallons per day: Total butane and lighter	Gallons per day: Total all nat. gasoline and L.P.G.
Arkansas	**1**	**52**	**32,000**	**37,000**	**69,000**
California	**2**	**225**	**120,641**	**192,250**	**312,891**
Louisiana	**14**	**1,389**	**1,776,400**	**586,634**	**2,363,034**
Mississippi	**1**	**115**	**33,000**	**30,000**	**63,000**
Oklahoma	**3**	**265**	**342,198**	**113,243**	**455,441**
Texas	**27**	**3,059**	**1,926,632**	**1,537,175**	**3,463,807**
Total	**48**	**5,105**	**4,230,871**	**2,496,302**	**6,727,173**

ARKANSAS

Plant location (field, county, and nearest town)—	Gas cap., M.M.c.f. per day	Natural gasoline and heavier, gal. per day	Total butane and lighter, gal. per day
McKamie Gas Cleaning Co.:			
McKamie-Patton, Lafayette (Magnolia)	52	32,000	37,000

CALIFORNIA

Ohio Oil Co.:			
S. Coles Levee, Kern (Bakersfield)	75	37,641	42,250
Western Gulf Oil Co.:			
Paloma, Kern (Bakersfield)	150	83,000	150,000
Total	225	120,641	192,250

LOUISIANA

Plant location (field, county, and nearest town)—	Gas cap., M.M.c.f. per day	Natural gasoline and heavier, gal. per day	Total butane and lighter, gal. per day
Acadia Corp.:			
Egan, Acadia (Egan)	120	100,000 (Motor fuel and heavier)	60,000
Bel Oil Corp.:			
N. Elton, Allen (Elton)	14	13,000	100
The California Co.:			
Lake St. John, Tensas (Waterproof)	115	100,000	70,000
Cotton Valley Operators Committee:			

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...from the bottom...while it's being run

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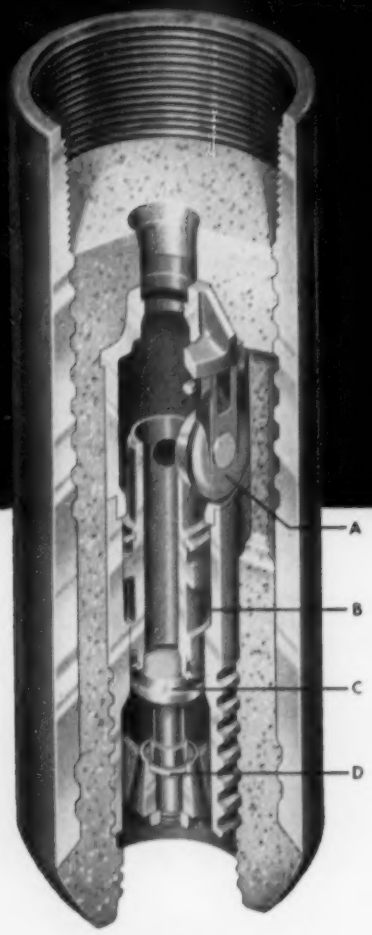
- **DIFFERENTIAL FILL-UP COLLARS**

Here's what DIFFERENTIAL FILL-UP Equipment does . . .

Permits the casing to *fill automatically from the bottom*, while it is being run, to within 90% of the fluid level of the annulus (using a shoe OR a collar)—or to within 81% of the fluid level of the annulus (using *both* a shoe AND a collar). In addition, a back-pressure valve is present to be used at the *discretion of the operator*, for "floating" or for cementing.



Baker DIFFERENTIAL FILL-UP Shoe, Product No. 1081.

A—Flapper Valve functions only at discretion of operator.
B—Sleeve Valve operates to control rate of flow and volume of "fill-up" fluid.
C—Sleeve Valve Seat.
D—Shear Ring is sheared. Flapper Valve now functions for floating or cementing.

Here's how Baker DIFFERENTIAL FILL-UP Equipment will aid you to avoid danger, increase rig efficiency, save valuable time and promote safety...

REDUCES THE DANGEROUS "RAM EFFECT" thus minimizing the hazard of breaking down a potential lost circulation zone.

SAVES COSTLY DRILLING MUD that might otherwise be lost to the formation due to the "ram effect."

MINIMIZES DAMAGE TO MUD CAKE on the wall of the hole. The majority of the fluid displaced as the casing string is lowered enters the casing instead of flowing up the annulus and causing possible damage to the mud cake.

REDUCES DANGER OF STICKING CASING by reducing to a minimum the "no-motion time" formerly required to fill casing at the surface—extremely important when running casing in directional holes or sloughing formations.

SAVES ONE-HALF THE RUNNING-IN TIME plus the proven advantages of Baker Floating Equipment, including a back-pressure valve for cementing.

KEEPS THE RIG FLOOR CLEAN AND SAFE by eliminating the messy spill-over and splattering of mud present when casing is filled at the surface.

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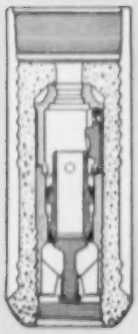
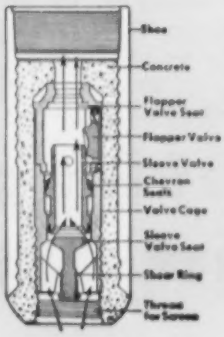
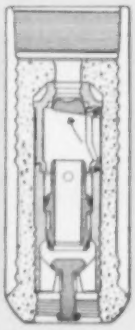


When running-in, the Sleeve Valve is in closed position in contact with the Sleeve Valve Seat. When the Sleeve Valve is in this position, fluid entry into the casing from below the valve is effectively blocked. The Sleeve Valve will be in the closed position whenever the height of the fluid column in the casing (the fill) EXCEEDS 90% of the height of the fluid column in the annulus.



When the height of the fluid column in the casing (the fill) is LESS than 90% of the height of the fluid column in the annulus, the Sleeve Valve moves upward away from the Seat and permits fluid entry into the casing through the bottom of the FILL-UP Shoe. During the casing run, the Sleeve Valve opens and closes according to the pressures imposed on its top and bottom areas and thus automatically regulates the degree of fill.



When it is time for cementing, pressure of approximately 1,000 psi is built up in the casing to shear the Shear Ring that holds the Sleeve Valve Seat in the supporting vanes of the Valve Cage. The Sleeve Valve can then move downward sufficiently to release the spring-loaded Flapper Valve, and thereafter the FILL-UP Shoe functions as a conventional Float Shoe.

Processing-Plant Survey

Plant location (field, county, and nearest town)—	Gas cap., M.M.c.f. per day	Natural gasoline and heavier, gal. per day	Total butane and lighter, gal. per day
Cotton Valley, Webster (Cotton Valley)	150	168,000 (Jet fuel) 126,000 (Motor fuel)	84,000
Gulf Oil Corp.-Gulf Refining Co.:			
Krotz Springs, St. Landry (Krotz Springs)	200	200,000 (12 lb. R.v.p.)	58,000
Magnolia Petroleum Co.:			
Opelousas plant, St. Landry (Opelousas)	23	None	3,834
Southwest Gas Producing Co.:			
Hico-Knowles, Lincoln (Dubach)	200	†100,000	80,000
Stanolind Oil & Gas Co.:			
S. Jennings, Jeff Davis (Jennings)	55	38,000	8,000
Sunray Mid-Continent Oil Co.:			
W. Tepetate, Jeff Davis (Elton)	20	10,000	7,000
S. Sarepta, Bossier-Webster (Benton)	15	64,000	14,000
Benton, Bossier (Benton)	85	82,000	42,000
Northwest Branch (Church Point)	27	107,000	13,100
The Texas Co.:			
Bateman Lake, St. Mary (Berwick)	145	*135,000	*8,000
Erath, Vermillion (Erath)	220	*533,400	*138,600
Total	1,389	1,776,400	586,634
MISSISSIPPI			
The California Co.:			
Cranfield, Adams (Natchez)	115	33,000	30,000
OKLAHOMA			
Gulf Oil Corp.:			
Glen Pool, Creek (Kiefer)	17	34,170	3,060
Magnolia Petroleum Co.:			
Chitwood, Grady (Rush Springs)	24	19,028	9,183
Shell Oil Co.:			
Elk City, Beckham (Elk City)	224	289,000	101,000
Total	265	342,198	113,243
TEXAS			
American Liberty Oil Co.:			
Blessing, Matagorda	30	21,000	3,360
The Chicago Corp.:			
Wardner plant, Nueces (Bishop)	165	76,000	42,000
Gulf Plains plant, Nueces (Bishop)	125	67,000	37,800
Coastal plant, Nueces (Bishop)	125	55,000	29,400
Delhi-Taylor Oil Corp.:			
McAllen, Hidalgo (McAllen)‡	165	None	37,000
Distillate Production Corp.:			
N. Houston, Harris (Houston)	75	40,000 (Motor fuel and heavier)	40,000
Duval Gasoline Co. (closed Jan. 26, 1956):			
Duval (Benavides)‡	6	4,100	3,200
Francitas Gas Co.:			
Francitas, Jackson	40	20,000	5,000
Gilring Oil Co.:			
Agua Dulce, Nueces (Banquette)	60	25,000	7,000
Humble Oil & Refining Co.:			
Julian, Kenedy (Encino)	8.2	*44,700	None
Katy, Waller (Katy)	555	*438,900	*518,700
La Gloria Oil & Gas Co.:			
La Gloria, Jim Wells-Brooks (Falfurias)	325	190,000 (Finished gasoline)	200,000
Lone Star Producing Co.:			
Opelika plant, Henderson (Murchison)	70	80,000	20,000
Carthage plant, Panola (Carthage)	100	100,000	None
Chapel Hill plant, Smith (Tyler)	45	90,000	40,000
Magnolia Petroleum Corp.:			
Seeligson, Jim Wells (Premont)	206	87,902	80,502
Midland Gasoline Corp.:			
Conroe, Montgomery (Conroe)	36	34,730	37,197
Plomo Co.:			
Brayton, Nueces (Robstown)	55	45,000	22,000
Plymouth Oil Co.:			
Plymouth, San Patricio (Sinton)	75	10,800	13,700
Shell Oil Co.:			
Sheridan, Colorado (Sheridan)	108	117,000	64,400
South-Tex Corp.:			
Agua Dulce (Robstown)	60	20,000	18,500
Stanolind Oil & Gas Co.:			
Old Ocean, Brazoria (Sweeny)	350	195,000	194,000
Superior Oil Co.:			
Ramsey-Lake Creek, Colorado-Montgomery (Alleyton-Conroe)	110	52,500 (2 plants operating as 1 unit with separate gas outlets)	52,416
Tide Water Associated Oil Co. (Southern Div.):			
Long Lake, Anderson (Palestine)	40	7,000	5,000
Cayuga, Anderson (Cayuga)	25	§10,000	§6,000
Trinity Gas Corp.:			
Sejita, Duval (Hebronville)		25,000	15,000
United Gas Pipe Line Co.:			
Cabeza Creek, Karnes (Runge)	100	*25,000	*45,000
Total	3,059	1,926,632	1,537,175

*Figures represent capacity, not production. †Plant now includes a U.O.P. Platformer, produces 87 and 95 octane number motor fuel. ‡Part cycled, part sold. §These products are transported to Long Lake as mixed stream for further processing. ‖Plant figures estimated.

Texas Leads in Plant Building and Expansion

IN new construction and expansion of facilities of field processing plants, the Journal survey shows Texas leading the country with 10 projects planned or under way. In Louisiana, two new projects are under way and will be completed this year. Two projects are under way in New Mexico, one in Kentucky, one in Oklahoma, and one in Kansas.

ARKANSAS FUEL OIL CORP.:

Procon, Inc., is building a new 900-bbl. Platforming unit at Arkansas Fuel's Panola plant at Carthage, Tex. Completion is scheduled for May 1956.

ATLANTA GAS CO.:

Baird Construction Co., of Tulsa is working on a $500,000 project for Atlanta, in Wise County, near Bridgeport, Tex. Completion is scheduled for July 1956.

ATLANTIC REFINING CO.:

Atlantic is planning an absorption plant for recovery of propane, butane, and natural gasoline. The plant, to be completed in 1957, will be near Crane, Tex. Contractor has not yet been selected.

EL PASO NATURAL GAS CO.:

Stearns-Roger, of Denver, is expanding existing facilities for El Paso Natural at two of the company's plants in New Mexico. The plants are at Blanco field, San Juan County, near Bloomfield, and at Wingate field, McKinley

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We've never owned an engine with Ford's ability to dig in and hang on in tough going. On our present job we're breezing right through 18 inches of frozen ground, and doing so with no noticeable increase in operating costs."

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Processing-Plant Survey

County, near Gallup. Work is expected to be completed sometime in 1957.

GULF NATURAL GAS CORP.:

The company has under construction a plant near Shreveport, La., to process gas from about 2,200 wells. The plant will have a daily capacity of 27,000,000 cu. ft. of natural gas. Estimated cost of the plant is $2,350,000. Completion is scheduled for fall 1956.

HONOLULU OIL CORP.:

The company plans to build a plant in Hockley County, Texas. Contractor has not yet been selected, but completion is scheduled for October 1956.

KENTUCKY WEST VIRGINIA GAS CO.:

The company is planning a new plant, to be completed next year, in Floyd County near Maytown, Ky. Plans are in the blueprint stage at present.

MAGNOLIA PETROLEUM CO.:

Magnolia is planning a new plant, to be completed September 1956, at Spivey-Grabs field in Harper County near Attica, Kan. Contractor has not yet been selected. Hudson Engineering Corp. of Houston, is building another plant for Magnolia at Parks Ranch field near Midland, Tex.

PHILLIPS PETROLEUM CO.:

Phillips has a plant under construction at Bradley field, Garvin County, near Lindsay, Okla. Gas capacity of the plant will be 50 M.M.c.f. per day, and combined natural-gasoline and L.P.G. capacity will be 160,000 gal. per day. The company also has a new plant under construction near Andrews, Tex. The plant will have a gas capacity of 80 M.M.c.f. per day, and a combined natural-gasoline and L.P.G. capacity of 400,000 gal. per day.

REEF FIELDS GASOLINE CORP.:

Holder Construction Co. of Snyder, Tex., is building a gas-gathering system extension to Reef Field's East Vealmoor plant. The system, scheduled to be completed in April 1956, is at Jo Mill field, Borden County, near Big Spring, Tex.

SINCLAIR OIL & GAS CO.:

The company has under construction an absorption plant near Eldorado, Tex.

SUN OIL CO.:

Sun is adding compressors and additional processing equipment to its plant at Jameson field, Coke County, near Colorado City, Tex. Completion is scheduled for April 1956.

TENNESSEE GAS TRANSMISSION CO.:

O. L. Olsen Co., of Houston, is building fractionating facilities for Tennessee Gas in Harris County, near La Porte, Tex. Completion is scheduled for the summer of 1956.

TIDE WATER ASSOCIATED OIL CO.:

Delta Engineering Corp., of Houston, is building a new plant for Tide Water at Venice field, Plaquemines Parish, near Venice, La. Completion is scheduled for June 1956.

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HOW MANAGEMENT DECIDES TO BUILD A GASOLINE PLANT

This four-article symposium on How Management Decides to Build a Gasoline Plant is based on the forum—To Build or Not to Build a Natural Gasoline Plant, Management Considerations—held at the annual meeting, Natural Gasoline Association of America, in Fort Worth last week.

Chairman of the forum was Albert Taylor, manager of gas division, Amerada Petroleum Corp., Tulsa. Besides the four articles presented here, W. L. Bowser, Atlantic Refining Co., Dallas, presented a paper entitled, "The Plant and Future Considerations." This paper was not available at press time.

Earlier Studies Posed Questions

by Frank Matheny

ONE of the first discussions on how management approaches a solution to the many problems related to gasoline-plant economics and designs was presented at the 1944 N.G.A.A. meeting.[1] The meaning of design in that paper referred not so much to the structural and processing concepts, but rather to a method of arriving at the basic premises on which the engineers could build the physical plant most suitable to the premises established.

Still more fundamentally, that paper was intended to show how management decided whether to build a plant at all.

A few of the highlights of that paper might assist in following the advances in the art as described in the remaining articles of this forum:

"Among the very many factors which must be considered before any gasoline manufacturer can ask his management to invest substantial sums of money in a gasoline plant are:

"The areal extent of the producing horizon, well spacing, thickness, porosity, and permeability of the producing sand; reservoir temperatures and pressures; reserves of both gas and oil in place; gasoline content of the gas; nitrogen, carbon dioxide and hydrogen sulfide content of the gas—not only at the time the plant is built but a prophecy for every year of the field's life.

"So far all these factors named lend themselves to fairly accurate determination. However, the real variables that make or break a gasoline-plant situation do not lie within the gasoline manufacturers' control—but must be fixed by the producers, and the regulatory bodies who in turn establish certain basic premises.

"I now refer to such things as allowables per well; whether the wells will be "stop-cocked" and the day's or week's allowable produced in a few hours; possibilities of pressure maintenance and if such a program is to be followed—what per cent of the produced gas is to be injected into the sand—at what stages of depletion pressure maintenance is to be started; and possibilities of gas lifting in the final stages of natural flow are very vital factors to the gasoline manufacturers.

"Also these producing methods in turn dictate the utilization of the residue gas and establish whether the plant operator can depend on some revenue from the sale of gas to help amortize his investment. Speculations as to prices of his products over the life of the project, the effect of income taxes on the earnings, and labor costs of the future must all be weighed into the melting pot from which the plant emerges.

"The southwestern oil fields are covered with vacant foundations which stand as monuments to the lack of those analyses or to the bad guesses of answers to some of the above questions."

Having thus stated the problems, the paper then showed how to develop the answers by applying basic analyses to a hypothetical oil field. From these studies emerged management's best estimates with and without gas injection of reserves of gas and liquids, gas volumes, compressor and field line requirements by years, results of market surveys for liquids and residue, etc.

Having thus depicted a method of arriving at the fundamentals, that paper ended with the information in the hands of the engineers to make the conventional designs, cost estimates, and economic payouts.

The other papers in this symposium will give a "look see" at the progress made along these lines since 1944.

Author is vice president and general manager, Sid Richardson Gasoline Co., Fort Worth.
References given at end of symposium.

Let's Look at the Payout

by R. W. Heath

THE reserves of available wet gas are probably the most important single requirement in controlling the construction of a natural-gasoline plant. In all probability the field in which we might contemplate building a plant has not been on production for any long period of time and therefore little or no production information is available to indicate the probable long-range performance of the field, or to indicate the probable reserves by this means.

Consequently, a study of the bottom-hole samples and cores must be made to secure an estimate of the probable gas available. The basic data that have to be secured to make this study, and the many factors that are involved, make the determination of the reserves by this method another speculation.

The fact that recognized reservoir engineers can come up with answers several hundred per cent apart indicates the basic problem that faces management. If management is pessimistic and uses the lowest values, the figures on minimum reserves might show

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a plant to be entirely uneconomic. On the other hand, if management is overly optimistic, the decision might be based on the maximum estimated reserves and the plant would never return the investment.

The choice of an average figure may, too, be the wrong approach; all of which leads to the thought that the question of reserves is speculative and is not a factor on which definite economic values can be placed.

Production rate . . . Assuming for the moment that we have agreed upon a reserve figure and that a plant still appears to be justified, then the rate of production at which these reserves will be produced becomes the major consideration. The natural-gasoline-plant operator is usually not in control of these production rates, especially if the gas to be treated belongs to others.

In general, though, the state allowable may provide a somewhat reasonable estimate of what might be expected in the immediate future. Assuming that the producing acreage is determined and the well pattern set, an initial production rate could probably be decided upon without too much difficulty, but now the real speculation faces both the engineers and management.

What is going to be the change in gas-oil ratios as the field is produced? Is there going to be a water drive that will maintain the reservoir pressures? Will there be a pressure-maintenance program that will tend to hold the original gas volumes or will the gas-oil ratios increase to the point where a much larger plant than originally contemplated might be required?

It would not be surprising if the final decision was to build a plant of sufficient capacity to efficiently handle the immediate volumes of gas and designed so that it can be expanded in its capacity at minimum cost. However, there are additional costs in following this procedure; but again this is a speculation that must be faced one way or the other.

Gas volume . . . A decision on the volume of gas to be treated does not solve the problem since undoubtedly a large share of the income to the plant will be from products and therefore the quality of the gas and its content of natural gasoline and lighter fractions is of utmost importance. Samples of the available gas must be used in determining the content. There is no reason to suppose that the contents secured by these tests represent what the plant will have available.

Undoubtedly the average temperature and pressure conditions under which the gas is separated from the oil will be different under actual operating conditions, and it is first necessary to convert the quality secured by the tests to that expected under normal operation. Maybe the words "normal operation" imply another speculation since the control of operating conditions will stay in the hands of either the producers or the production department and they may well decide to increase the trap or separator pressures to the point that the available content is materially reduced.

In case of repressuring operations in the future, the decision may be made by others to separate the gas from the oil under two-stage operation. Since the majority of the gas will come from the first stage of separation, such a move on the part of the producers would seriously handicap the gasoline-plant operator. The engineer and management must face these speculations to decide upon the probable value of reduced trap or separator pressure through the increased yield of available plant products.

To secure minimum pressures requires much larger gathering lines and much greater compressor capacity. Reducing the plant intake pressure from 50 psi. to 5 psi. may double the compressor requirements. This is another major speculation in connection with the decision to build and, if so, what to build.

Product values . . . After reaching this point, if the area still appears to justify a natural-gasoline operation and reasonable casing-head contracts can be secured, another hurdle and another speculation have to be faced in arriving at the values that are to be used for the products extracted and the determination of the design efficiency of the proposed plant. The history of prices for both natural gasoline and L.P.G. provides little indication of what might be expected in the future.

The factors involved in the pricing of these products are certainly too numerous to go into at this time and the end result seems to be that little assurance can be given that they will maintain their existing price levels or remain in reasonable ratio to other petroleum products or to commodity prices in general. The history of natural-gasoline prices will show changes of over 100 per cent in many past years. These variations exist today but they are certainly not new.

Some 25 years ago I operated my first plant in the Mid-Continent. In those days there was no control of production rates and therefore these volumes varied tremendously with the new wells that were developed from time to time. We had the sad experience of receiving 12 cents per gallon for our natural when we produced 10,000 gal. per day and less than 1 cent per gallon when we produced 100,000 gal. per day.

Obviously, a tremendous speculation factor has to be used in any consideration of natural-gasoline prices. The sales value of the lighter products is also indeterminate. The market area in which the plant is located is of utmost importance. There is the problem of selling a reasonable proportion of the products in the summer. Should underground storage be feasible there is the added speculation that the underground storage would not be completely satisfactory and that there will not be full recovery of the products stored.

There is also the question of whether additional winter sales would be sufficiently guaranteed to justify the costs of such an endeavor, especially if conditions were not considered ideal for such a storage development. There is therefore a basic speculation as to the reasonable price to be used for these lighter products in the necessary economic study and their application to the decision on plant design and the degree of their extraction that can be justified.

Sale of residue gas . . . Now, if we still wish to continue with the plant and are willing to face the fact that we are not at all certain of our reserves, our future production rate, the contents that will be available, or the prices that we will secure, we come to the question of the sale of the residue gas. Normally this, too, is a major consideration.

However, here again we are faced with the problem that the producers may be in a position to use this gas for repressuring the producing reservoir and it must therefore be returned to them, with the result that any revenue from this source may be delayed to the point where its present worth value is of little significance. But suppose we proceed, and after much negotiation secure a good residue contract with a good take and a good price with an established interstate pipeline purchaser capable of handling our complete plant output.

However, even after such a contract has been agreed upon, the speculation really becomes apparent for it may well be that over a year later—perhaps long after the plant has begun to operate—the Government will step in and say that the price that has been negotiated is not acceptable.

Even if the Harris bill had been passed, this condition would not have been entirely different, since it was obvious that no interstate purchaser would

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pay more for the gas than it was able to include in its rate structure and thus get its money back. On the other hand, the Harris bill would have provided protection to the independent producer in the production, gathering, and processing of the gas before the sale to the interstate purchaser and would have avoided the question of these operations being considered on a utility rate base.

With this protection gone, management must face the added speculation that the Federal Power Commission, and possibly intervening parties, will use every means at their disposal to place these operations on a fixed rate of return on the total plant investment. Any of you who have had recent experience before the FPC will know of the constant efforts on its part to show that a fair and reasonable price for the residue gas should depend upon the return that the independent producer is receiving from his operations, whether they be involved with the production and sale of crude oil, natural gasoline, or the liquid products that are extracted.

Therefore, we must face the unknown danger of future regulation by the FPC. We have the knowledge that the commission has strongly asserted jurisdiction, even though it has failed to provide the criteria for the pricing of the independent producers' gas. I know it is a shocking thing to all of us in the natural-gasoline industry to consider that a natural-gasoline plant can conceivably be considered on a utility basis.

Utility basis? . . . We can see from these speculations that the industry is faced with an entire set of conditions that cannot possibly be reasonably considered on any utility base approach. However, there are those in the FPC who are seeking a formula which could be so applied to our operations. If the plant is successful the FPC might well apply the utility rate base to include the revenues from the liquids. This could obviously result in an absurdly low, or even a negative price, for the residue gas.

If the plant proves to be a poor venture, the commission may still find some pretext to reduce the residue contract price to the supposed area price or some other lower and arbitrary figure, and certainly under this condition would not allow a price to provide a utility rate of return.

Management must now face the fact that a certificate of public convenience and necessity must be secured from the FPC before deliveries are made and that any contract price and other terms are subject to the very broad powers of the commission—powers, which the speaker has already found to his sorrow, that the commission may apply to even a certificate proceeding. This whole subject is certainly one on which I hate to even speculate.

Other factors . . . There are many other important factors which must be weighed in arriving at the economic considerations justifying the construction of a gasoline plant. The whole approach must be to weigh each speculation and in each case the experience of the men making the decision is obviously of utmost importance.

However, there may be a danger in bypassing the detailed studies and attempting to justify a new plant on data and decisions reached on a somewhat comparable study of another plant in a different oil or gas field. While the same speculations may apply to values, the majority of factors are at least sufficiently different in each case to require individual study.

The costs involved do not allow any additional hazards to be added beyond those still facing management after the most complete study of all factors. At any rate, it is obvious that the decision to build a natural-gasoline plant is not comparable to the business risks faced in making comparable expenditures in other industries today.

Good engineering practice and a practical economic study will reduce the hazards to a minimum, and experience with these problems will allow the proper decision to be made by those undertaking the construction and operation of a new plant.

Economics of Ethane Recovery

by H. H. Beeson

THE natural-gas industry has recently added the sale of another product—ethane. This hydrocarbon is recovered by all plants to some extent incidental to the usual recovery of propane and the heavier hydrocarbon products. This ethane had always been available either as a component in gases taken to fuel or as additional vapor pressure in propane product.

Ethane is a gas at normal atmospheric temperature and pressure and is the hydrocarbon next lighter than propane. It has a molecular weight of 30.068, a boiling point at atmospheric pressure of —127.5° F., and an extrapolated vapor pressure of 100° F. of 780 psia. Pure ethane has a critical temperature of 90.1° F. and a critical pressure of 708 psia.

These critical conditions mean that the pure component cannot exist as a liquid above a temperature of 90.1° F. Pipelines operating at temperatures higher than the critical convey pure ethane as the highly compressed gas.

Valuable material . . . Ethane is a valuable raw material and is used by chemical plants for manufacturing ethylene products. Refineries have sold ethane-ethylene mixture for years, but it has only been recently that our branch of the petroleum industry has entered into the sale of this production.

Until recently the principal use of ethylene was for ethyl alcohol and glycol products, but now it looks as if the field of plastics will become a leading consumer of this material due to the development of polyethylene and its related plastic products.

There have been several companies recovering ethane for their own use for about 30 years. One of the first sales of ethane from a gasoline or cycling plant was on the Gulf Coast a number of years ago, wherein a propane-ethane mixture was recovered and sold to a chemical plant.

The initial deliveries of this material contained approximately 25 per cent ethane which has now been increased to 35 per cent. Deliveries were made as a liquid into buyer's pipeline. The product was not broken down into components for payment, but has been sold as a mixture at so many cents per gallon.

Chemical sales . . . In 1950 a large chemical company began negotiating for the purchase of an ethane-methane mixture for their proposed plant to be built on the lower Texas Gulf Coast. Contracts were completed for the purchase of a methane-ethane mixture containing approximately 35 per cent ethane from two plants and a 90 per cent pure product from a third plant.

Prices paid were 50 cents per M.c.f. for the ethane and all heavier constituents, which is equivalent to approximately 2 cents per gallon, and residue-gas value for the methane portion. This material is all delivered as a gas stream at the plant outlet into the buyer's pipeline for movement to its plants.

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Later, a pipeline company proposed to buy ethane mixture from plants in North Louisiana and transport same to markets in the north central industrial area of the United States. It was proposed to purchase a material similar to that purchased in South Texas. This purchase has not been concluded.

Cost to Recover

The delivery of a mixture of ethane and methane can be accomplished at comparatively low recovery for nominal additional plant costs. The additional equipment necessary for such additions may run as high as $50,000 per million cubic feet of ethane per day, which would pay out in less than 6 months.

In order to recover ethane as a commercially pure product and sell like other liquid products would be quite expensive if not impossible because of critical temperature limitations. In order to sell liquid ethane from tanks, refrigerated storage and special means of moving would be required.

In order to recover a high percentage of ethane in an absorption type of plant, a high oil-circulation rate would be required. This would also result in a high degree of methane recovery creating a problem of further purification in order to deliver a product of reasonable purity.

A plant could be originally designed for high ethane recovery by refrigerating the inlet gas for product recovery, taking the temperature down to 150° or 200° below zero. This type of plant has been proposed in several locations for high propane recovery but none has yet been built except in refinery operations.

In such plant the desired recovery can be obtained and it would be a relatively simple matter to produce the required degree of purity of product. The economics of such a plant with high ethane recovery would depend upon the content of the gas, price expected from the sale of products, and the usual items to be considered in the building of any plant.

Residue heating value . . . Most plant residue-gas sales contracts provide for gas having a B.t.u. value of 1,000 with no premium for a higher B.t.u. but with penalty if the heating value falls below 1,000. The usual residue gas has a B.t.u. value in excess of 1,000 and ethane may be economically removed without lowering the heating value below 1,000; hence, no penalty. The only decrease in revenue from residue-gas sales would be the volumetric loss.

However, this would not be true if the residue gas sales contract provided for a price increase for B.t.u. over 1,000. This may make a very important effect upon the economics of ethane recovery.

For illustration, suppose that a plant is selling ethane for 50 cents per M.c.f. and residue gas at 12 cents per M.c.f., adjusted for heating content over or under 1,000 B.t.u. If prior to ethane extraction the heat content of residue gas was 1,200 B.t.u., the adjusted price would be 14.4 cents per M.c.f. By extraction of ethane, the heating value would be reduced to 1,100 and the sales price would thereby be reduced to 13.2 cents per M.c.f.

One hundred and forty-seven cubic feet of ethane per M.c.f. would be produced which, with an allowance of 30 cu. ft. for fuel, would result in a further deduction from the income from the sale of residue gas. One thousand cubic feet of residue would otherwise be sold at 14.4 cents; now only 823 cu. ft. will be sold at a rate of 13.2 cents per M.c.f. or 10.86 cents. To compensate for this loss, 147 cu. ft. of ethane would be sold at 50 cents per M.c.f. or for 7.35 cents, making a net increase of 3.8 cents for each M.c.f. of otherwise salable residue gas.

This would be a realization of 25.9 cents per M.c.f. of ethane or 1.03 cents per gallon. If no appreciable additional plant investment were required, this would be a profitable sale. In one case it has been estimated that an expenditure would be required which when depreciated at 6 per cent would be equivalent to 0.835 cent per gallon. Applying this additional cost to the above cost per M.c.f. figures would reduce this income by 3.1 cents per M.c.f. of otherwise salable residue gas or leave a net of 0.7 cent per M.c.f. to cover operating expenses, payments to sellers of casing-head gas and profit.

Conclusion

All of the facts relative to the plant need be analyzed and evaluated before a decision can be reached as to whether or not ethane recovery would be profitable and to what extent. Some of the main points to be considered are:

1. Analysis of inlet gas.
2. Cost of additional plant investment for ethane recovery.
3. Type of residue gas sales contract and price payable thereunder.
4. Market and sales price for ethane product.
5. Desired quality of product.

Reservoir Studies and Recovery Methods Shape the Decision

by W. L. Horner

LEADERS in the natural-gasoline industry have advocated the use of reservoir studies to improve the profits from operations. Reservoir engineering has also been recommended to evaluate prospects for gasoline plants. As a basic requirement for sound design, for financing, and for operation, reservoir engineering now receives attention from everyone concerned with producing natural gasoline.

On questions of whether to build or not to build a plant, reservoir engineering involves thorough studies of the reservoir and the recovery methods. The studies provide estimates of the volume and composition of gas to be produced and are carried through to economic projections of plant income and payout.

Serious interest in reservoir studies was recommended by W. F. Matheny at the twenty-third annual convention of N.G.A.A. in 1944.[1] F. E. Rice in 1949 advocated "every technical man in natural gasoline could well afford to study petroleum engineering, plus reservoir economics, to properly evaluate his operations and job (natural gasoline) with that of crude oil production."[2]

Plant owners also need reservoir studies as a requirement for financing gasoline plants. Before the thirty-first annual convention of N.G.A.A., Guy C. Kiddoo stated that, from his point of view as a banker, "ample gas reserves are required to justify the construction or enlargement of a natural-gasoline plant" . . . and "reserve estimates must be prepared by thoroughly competent qualified engineers, whose judgment is not influenced by any considerations of personal profit."[3]

Accuracy needed . . . Competition for plant gas reserves has required more and more accurate estimates of wet gas supply. Forecasting reserves for gas fields is less complicated than for

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oil fields with dissolved and associated gas.

This article shows data on several representative examples of engineering studies to determine supplies of wet gas from oil fields.

A vast amount of information on such projects testifies most forcefully to the growth of reservoir engineering along with the growth of the natural-gasoline industry.

Among important reasons for growth of the natural-gasoline industry are large supplies of wet (rich) gas and the gradual elimination of unnecessary venting or flaring of gas, coupled with growth in the importance of gas-injection projects and unitized operations to increase oil recovery.

It has been stated that "natural-gasoline-plant operations have always been secondary in importance to oil production."[1] The relative importance of plants is improved by the lighter type of oil being found with deep drilling and by developments in gas injection and unitization.

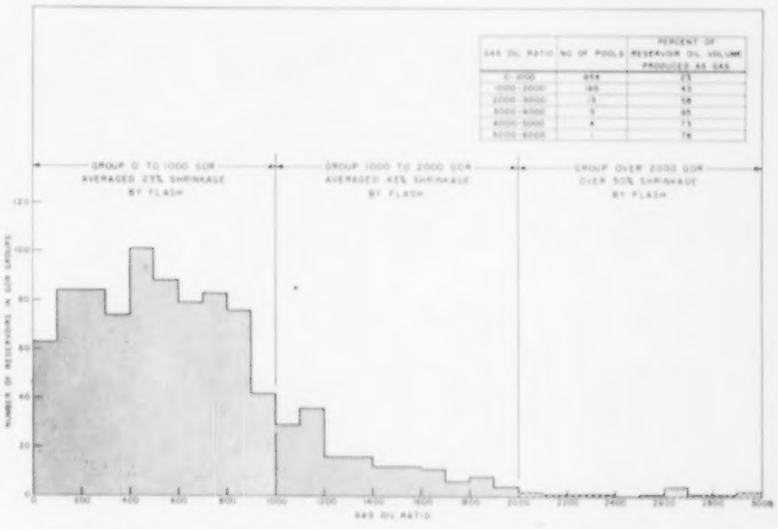
Currently, with deep drilling, reservoir oil is being found which contains large amounts of dissolved gas. In many of the deep oil reservoirs, over one-half of the reservoir oil is dissolved gas. The importance of natural-gasoline operations is obvious in such fields.

Reservoir fluids . . . A random group of more than 1,000 U. S. samples of reservoir fluid showed dissolved gas-oil ratios of one sample in excess of 5,000 cu. ft. per barrel; five in excess of 4,000 cu. ft. per barrel; and eight in excess of 3,000 cu. ft. per barrel (Fig. 1). Twenty-one of the samples had gas-oil ratios in excess of 2,000 cu. ft. per barrel.

In the 21 samples, from 57 to 78 per cent of the reservoir oil became gas at surface stock-tank conditions in the oil field. Ninety-eight per cent of the samples evidenced gas-oil ratios of less than 2,000 cu. ft. per barrel. Of the 98 per cent, approximately one-fourth of the reservoir oil vaporized to gas phase when flashed in oil-field handling.

As deep drilling has found some reservoir oils that vaporize mostly to gas, it has also found some occurrences of gas very rich in liquids. The dividing line between oil and gas cannot be defined precisely in terms of gas-oil ratio alone.[4]

In seven cases recently reported, the recoverable liquid content of the reservoir gas exceeded 90 bbl. per million cubic feet of gas.[5]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PERCENT OF RESERVOIR OIL VOLUME PRODUCED AS GAS
GROUP 0 TO 1000 GOR AVERAGED 23% SHRINKAGE BY FLASH
GROUP 1000 TO 2000 GOR AVERAGED 45% SHRINKAGE BY FLASH
GROUP OVER 2000 GOR OVER 50% SHRINKAGE BY FLASH
NUMBER OF RESERVOIRS IN GOR GROUPS
GAS OIL RATIO

Fig. 1—Distribution of gas-oil ratio and shrinkage for 1,040 samples of reservoir oil.

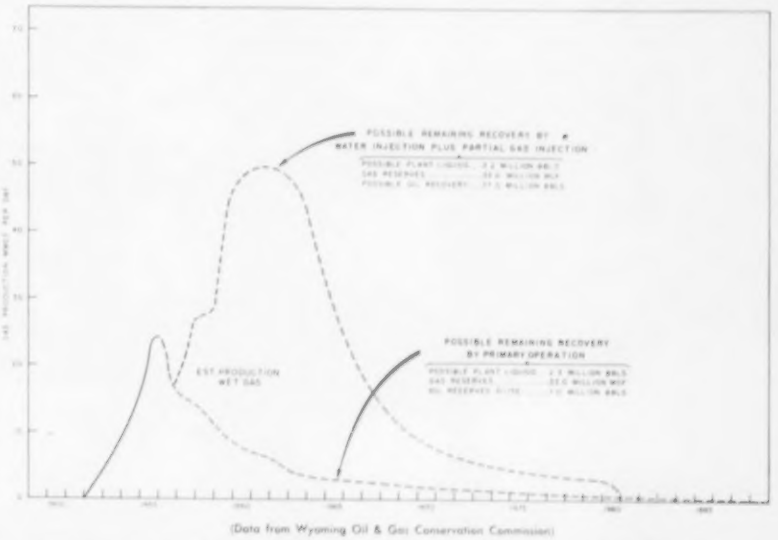
POSSIBLE REMAINING RECOVERY BY WATER INJECTION PLUS PARTIAL GAS INJECTION
POSSIBLE REMAINING RECOVERY BY PRIMARY OPERATION
EST. PRODUCTION WET GAS
(Data from Wyoming Oil & Gas Conservation Commission)

Fig. 2—Greater Clareton area, Wyoming, estimate of gas production rates and remaining plant liquids possible.

Injection survey . . . A survey of unitized injection operating December 31, 1954,[6] revealed 149 gas-injection projects are estimated to increase recovery of oil by around 3 billion barrels. Of the 149 projects, 58 were cycling and 37 were also injecting water cojointly with gas.

Operators of these unitized gas-injection projects have indicated they expected recovery by primary depletion to average about 28 per cent of the stock-tank oil initially in place. From the same reservoirs, 45 per cent recovery is expected with unitized inpection operations.

Recovery of greater amounts of oil and maximum amounts of natural-gasoline liquids may be forecast under certain newly developed concepts and techniques of gas injection, applicable in special cases. Such projects are operating in Texas in the Block 31 Devonian field and in Picton field.

Condensing gas drive . . . "Laboratory studies have indicated that displacement of oil from a reserervoir by means of a condensing gas drive results in extremely high oil recovery, approaching 100 per cent under the most favorable circumstances. A condensing gas drive is defined as a gas drive in which the gas utilized is appreciably soluble in the oil it is displacing."[7]

H. L. Stone and J. S. Crump, authors of that statement in a paper, also

COOPER-BESSEMER

V-ANGLES

"Put the squeeze" on synthesis gas for a giant ammonia producer

At Lion Oil's Barton plant, six Cooper-Bessemer compressors, each rated 2500 hp at 250 rpm, handle the compression of gas for ammonia synthesis for agricultural chemical production.

Fifteen thousand is the total available compressor horsepower of six Cooper-Bessemer V-angles in operation at Lion Oil's big, modern Barton plant, not far from New Orleans.

ANGLE

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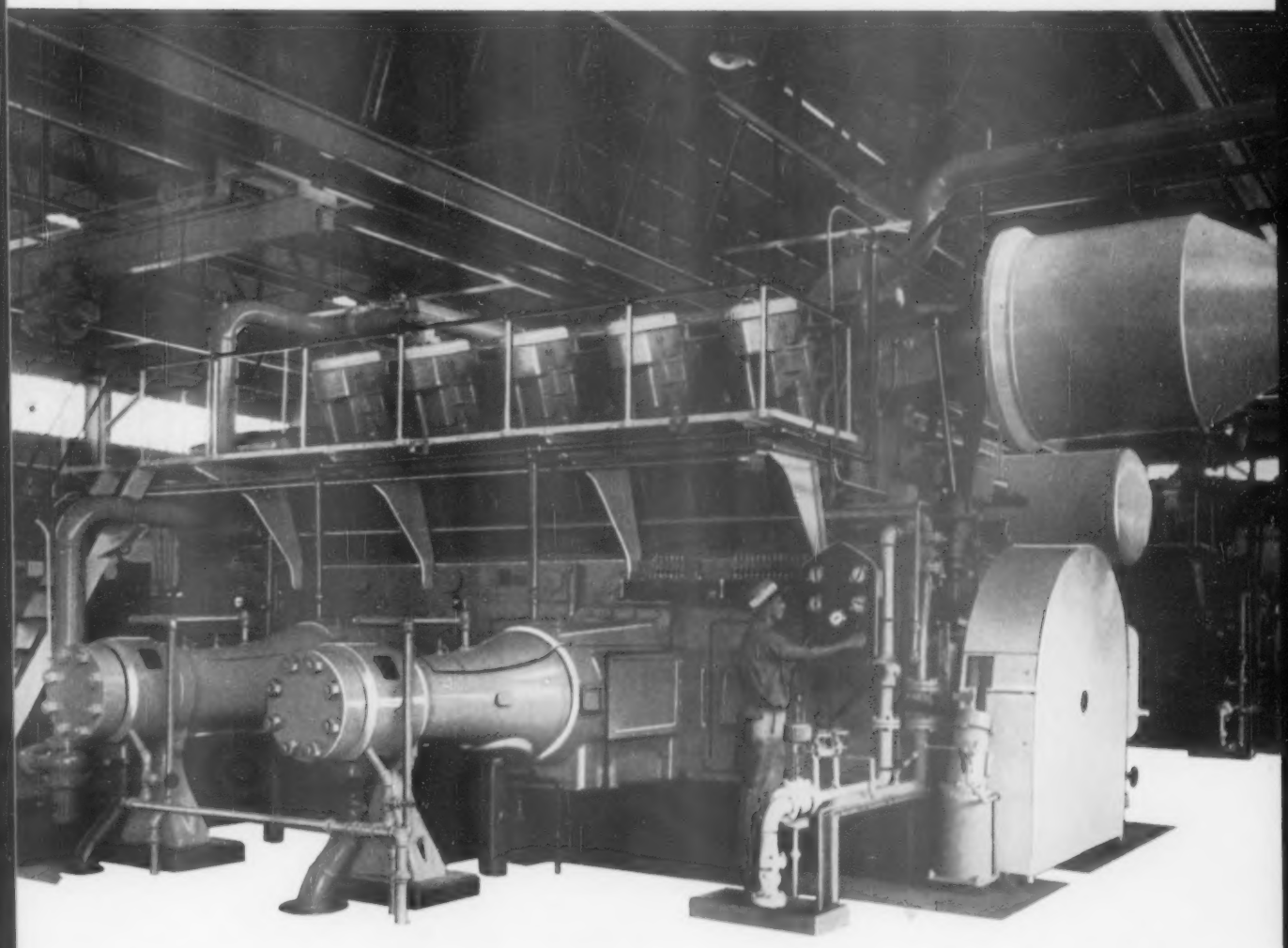

● At Lion Oil Company's $31,000,000 Barton plant near Luling, Louisiana, six 2500 hp Cooper-Bessemer V-angle compressors have gone to work compressing huge quantities of gas for ammonia synthesis.

Operating on a day and night schedule, these engine driven Cooper-Bessemers help produce 90,000 tons of nitrogen a year in the form of anhydrous ammonia and pelleted ammonia nitrate used as fertilizer.

One major feature of the Barton plant is the compactness of compressor equipment. Important reductions in piping, foundations, installation time and building expense are made possible by utilizing only six V-angle units to deliver 15,000 compressor horsepower.

Flexibility to meet varying conditions, durability for continuous operation and efficiency for low-cost performance are three more reasons why so many Cooper-Bessemers are found in similar outstanding plants throughout the nation. The nearest Cooper-Bessemer office will gladly help you select the ideal compressor to best meet your particular needs.

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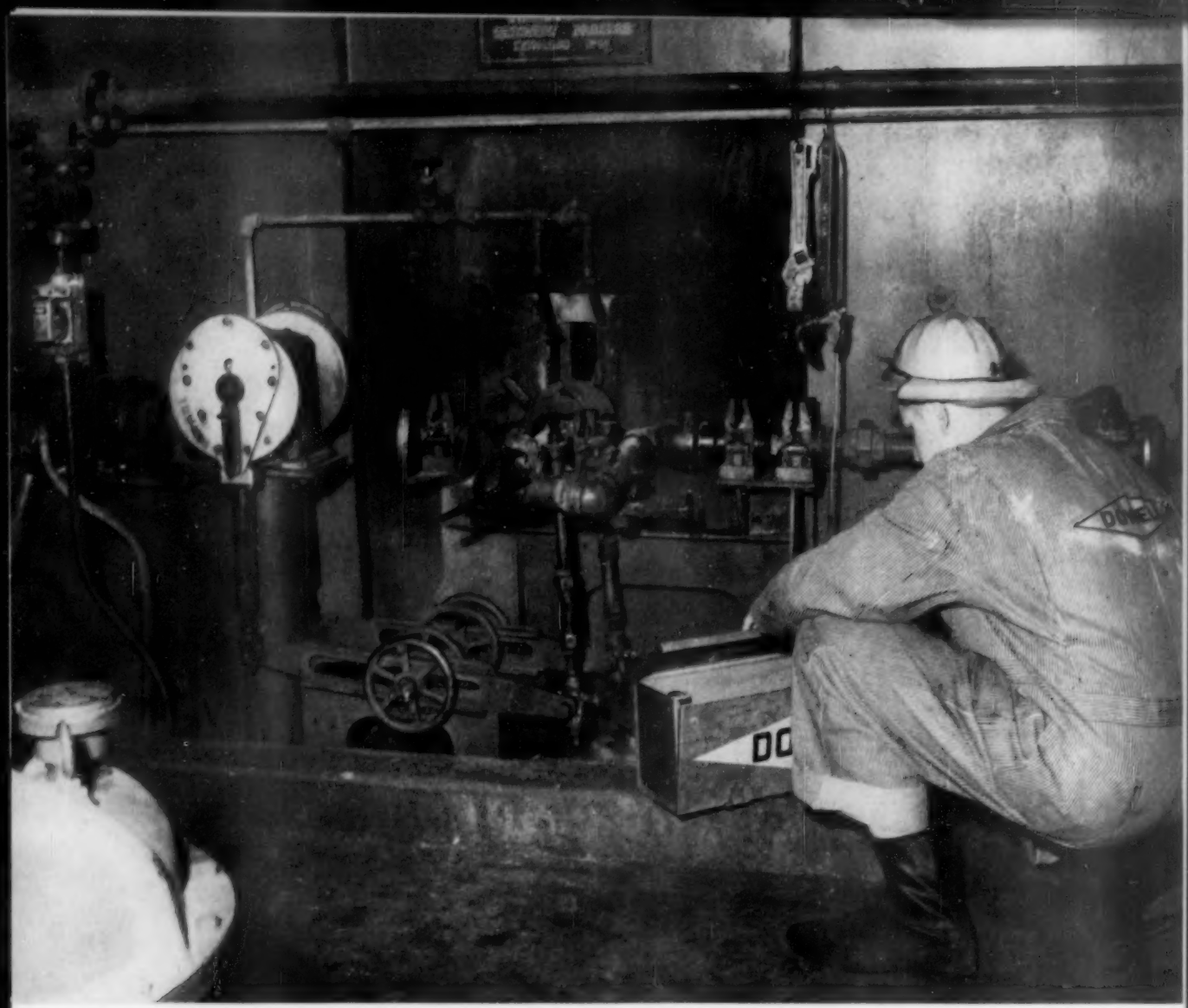

The risk is too great —clean it right

You don't take risks when men, equipment, and lost production time are involved. That's why more and more companies are investigating the methods and firms used in their chemical cleaning. They know it's work for experts.

What are they concerned about?

First, they want to know they are getting the benefits of experience. These benefits include less downtime and more thorough cleaning. Dowell has this experience with over 15 years and 10,000 boilers alone to their credit. In saving downtime, Dowell often cleans equipment while it is in operation.

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Call the Dowell office near you. Dowell engineers are ready to discuss and help you with your cleaning problems any time, at no obligation. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. D-11.

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Symposium

point out that a large portion of liquid recovery in such cases is condensed from the gas phase and that greater recovery is obtained when oil at reservoir conditions is capable of dissolving maximum amounts of gas.

The survey of unitized fileds[6] also showed a total of 190 unitized water-injection projects. These projects were mainly water-flooding type and included pressure maintenance also cojoint water injection with cycling and gas-injection pressure maintenance. The 190 projects are estimated to yield 50 per cent of the oil initially in place, as compared to 26 per cent estimated without the benefit of unitization, a gain of 2½ billion barrels of oil.

More unitization . . . In fields where possible, efforts are being made to unitize more reservoirs. The gains in estimated recovery usually provide string economic incentive factors to the oil producers and royalty owners.

The factor of rate of plant income, however, is usually controlled by oil allowables that are set after public hearings. Operators of successful injection projects usually are granted steady allowables, but they also request increased allowables to recognize the gains in reserves and in producing ability.

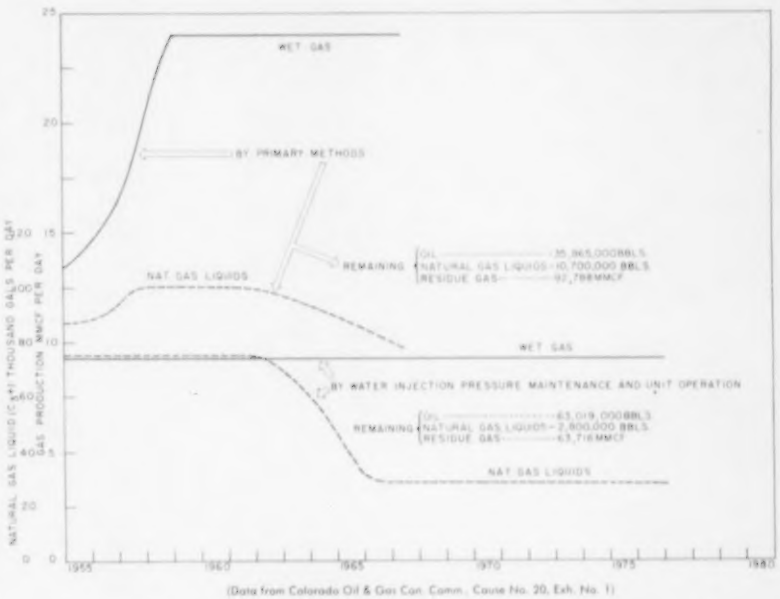
In some fields, the choice between operating or injection methods is difficult without the most intensive of engineering studies. Allowables are a factor in such studies. Sometimes the best selection is not possible when it depends on having unrestricted availability of plant residue gas. The interrelation between reservoir engineering and plant management is most vital on this problem.

Greater Clarenton Area, Wyoming

The Greater Clarenton area of eastern Wyoming is one of the largest new fields. It was drilled mostly in 1954, and its operators are facing the question of whether to build or not to build a natural-gasoline plant to serve the bulk of the production. Two relatively small plants are in operation in the south extremity of the field.

Rleased in November 1955, a comprehensive reservoir engineering report provided forecasts of oil and gas production under various methods of operation. The report was authorized by the Wyominging Oil and Gas Conservation Commission, at the request of the interested operators in the field.[8]

The first step in the studies authorized was a survey of the oil and gas production rates of each of the 641 producing wells in the 50,000-acre productive area. Samples of reservoir fluid and samples of separator gas were taken for laboratory analysis.



(Data from Colorado Oil & Gas Con. Comm., Cause No. 20, Exh. No. 1)

Fig. 3—"J" Sand field, Colorado, estimates of possible gas and liquid production.

A bottom-hole-pressure survey was conducted and all the available data on core analyses, electric logs and well-completion information were obtained and studied. Special cores - analysis measurements were made to determine the displacement characteristics for engineering calculations of recovery by various methods of operation.

The report revealed that a total of 2.3 million barrels of natural-gasoline liquids could be recovered by plants during the remainder of the life of the under primary methods of operation (Fig. 2). With gas and water injection, the possible recovery of plant liquids would be raised to 3.2 million barrels and with gas injection alone, to 4.5 million barrels. Gas reserves were estimated at 33 millioin M.c.f.

While considering the plant economics, the operators see reserves of 7.6 million barrels of oil by present primary methods of operation, the possibility of increasing future recovery to 14.3 million barrels of oil by injecting gas, 32.6 million barrels by injecting water, and 37.1 million barrels by injecting both gas and water.

A "J" Sand Field

One of the largest reserves of oil and gas in the Denver-Julesburg basin was developed in a "J" sand reservoir. About 8,300 acres are oil productive, and another 5,000 acres gas productive.

Discovered in November 1953, the field has 186 oil and gas wells, producing at an average depth of 5,650 ft. During the peak of the drilling activity in 1954, the principal operators of the field led the formation of an operators' committee.

The committee immediately took steps to promote conservation. It engaged an independent consultant to prepare a comprehensive reservoir engineering study and to recommend on the following:

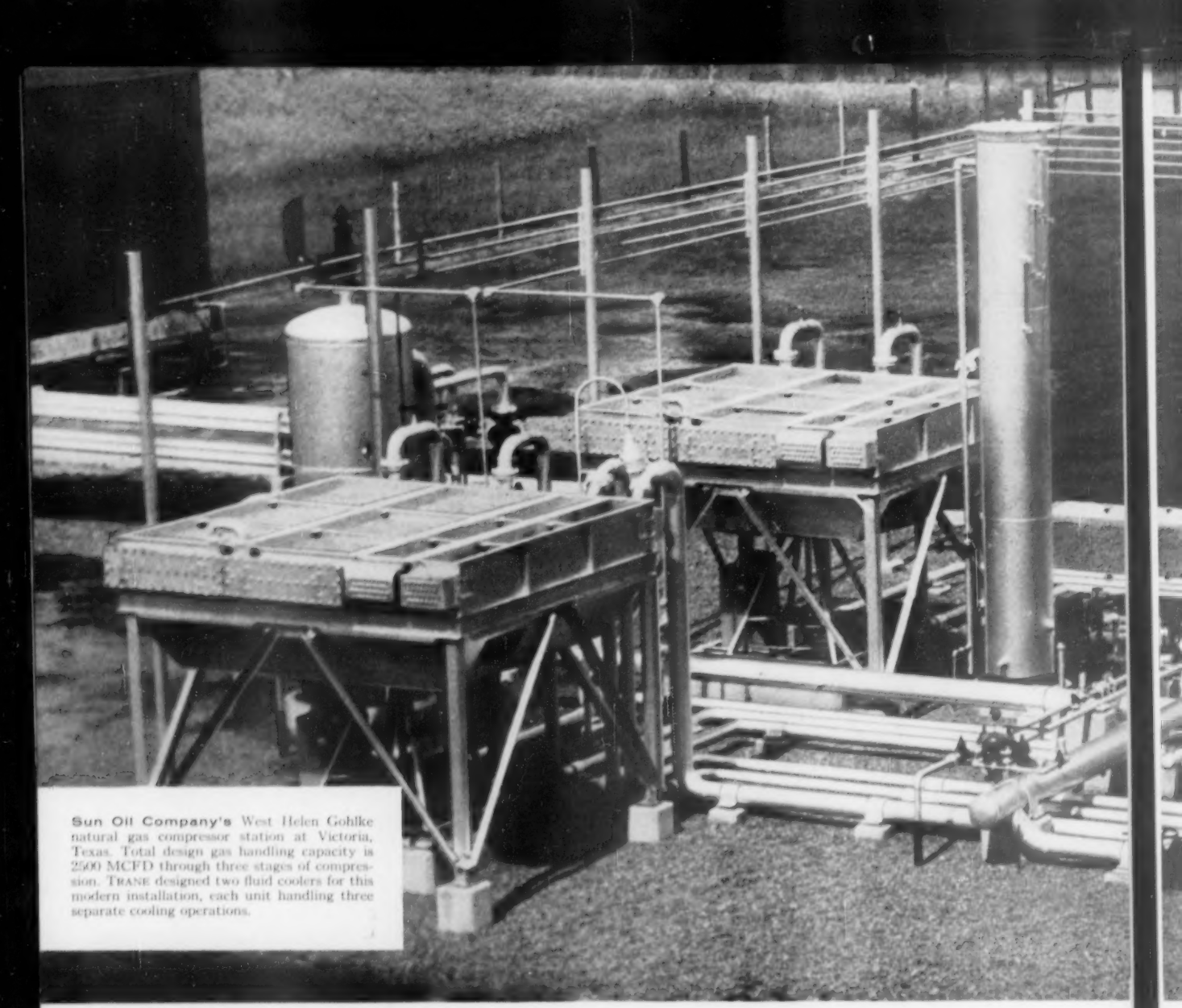
1. Need of a gas compressor station.
2. Need of a gasoline plant.
3. Whether the operators or some private individual should build a gasoline plant if needed.
4. Whether to reinject or sell the dry gas.
5. Need for pressure maintenance.
6. Economics of gas injection vs. water injection in pressure maintenance.

Within the next year, the operators had a jointly owned gasoline plant constructed to serve the field. They also commenced pipeline sales of residue gas.

Of major importance, they had formed a field-wide unit of "J" sand production for the purpose of increasing recovery, the first unit approved by the Colorado Oil and Gas Conservation Commission. At the unitization hearing in Denver on December 20, 1955, there were registered little opposition, and from only one operator.

Reserve estimates . . . The independent engineering report[9] gave estimates of reserves of oil and gas and the content and deliverability of wet gas under several possible field operating methods (Fig. 3).

It was determined that, without unit-



Sun Oil Company's West Helen Gohlke natural gas compressor station at Victoria, Texas. Total design gas handling capacity is 2500 MCFD through three stages of compression. TRANE designed two fluid coolers for this modern installation, each unit handling three separate cooling operations.

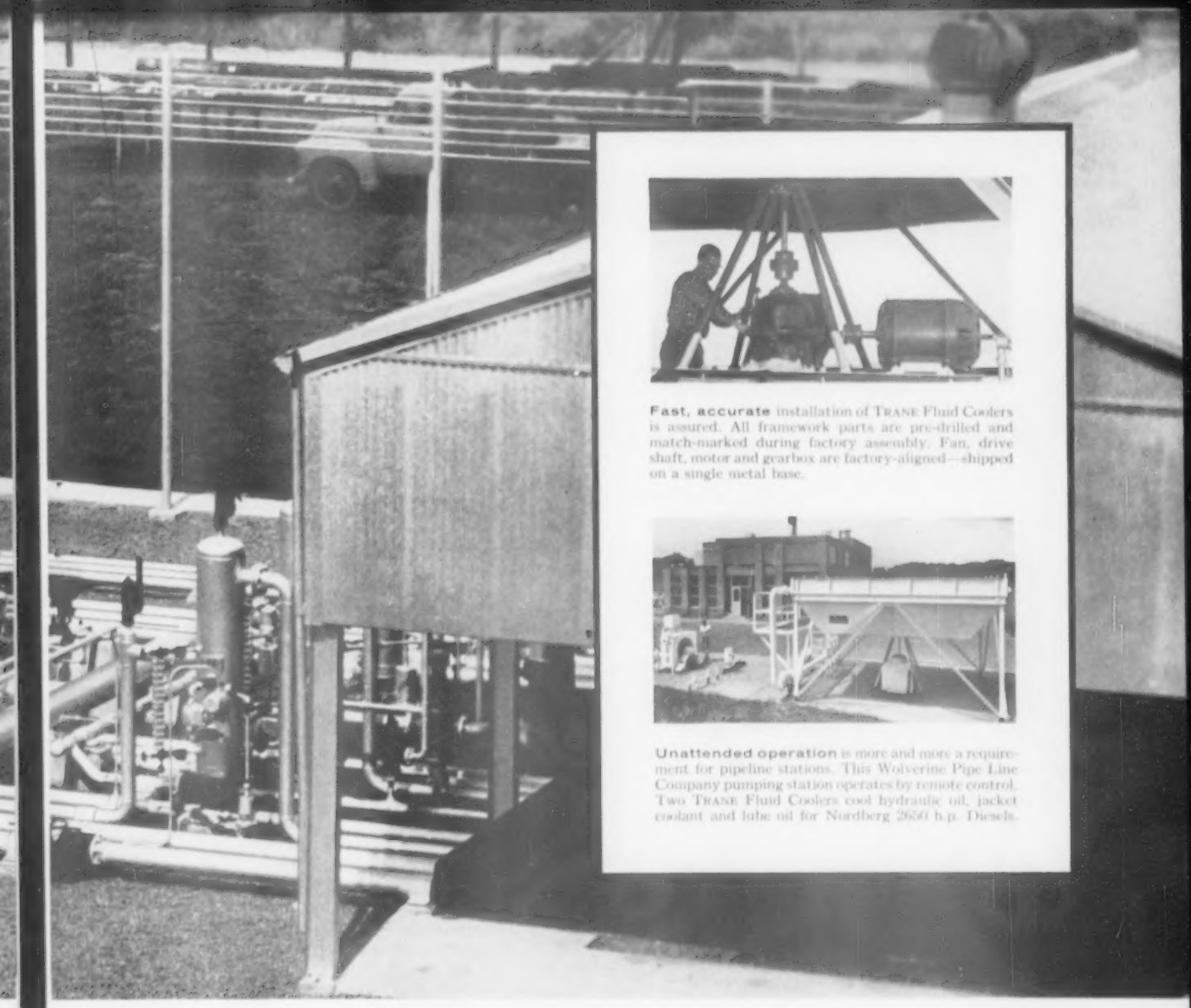
All 3 cooling operations each Trane Fluid Cooler:

Sun Oil chooses Trane equipment for an important fluid cooling job!

When the Sun Oil Company wanted two fluid coolers for the West Helen Gohlke natural gas compressor station, TRANE designed a cooler capable of performing these three cooling operations:

1. Sub-cool the jacket water from the engines.
2. Cool the compressed gas during the first stage of compression at 110 psia.
3. Cool the gas during the second stage of compression at 360 psia.

All three operations were incorporated by TRANE in one compact fluid cooler package. *One* unit solved *three* major cooling jobs! Header design on the high pressure coils meets all API-ASME code requirements for unfired pressure vessels. Also, coil tubes are cleanable, with



Fast, accurate installation of TRANE Fluid Coolers is assured. All framework parts are pre-drilled and match-marked during factory assembly. Fan, drive shaft, motor and gearbox are factory-aligned—shipped on a single metal base.

Unattended operation is more and more a requirement for pipeline stations. This Wolverine Pipe Line Company pumping station operates by remote control. Two TRANE Fluid Coolers cool hydraulic oil, jacket coolant and lube oil for Nordberg 2650 h.p. Diesels.

for Sun Oil handled with

engine jacket water · 1st-stage gas · 2nd-stage gas

at 110 psia at 360 psia

full-access headers. Framework is rugged, durable; units meet specific horsepower and capacity requirements.

The TRANE equipment handled this important fluid cooling job efficiently, economically—and erection time was substantially less than anticipated, too.

Solving cooling problems like this is TRANE's business! TRANE has thirty years of experience covering all types of fans and coils under all types of operating conditions—plus a large backlog of supporting engineering and laboratory test data.

What's your problem? For complete information on how TRANE can help *you*, call your nearby TRANE Sales Office or write TRANE, La Crosse, Wis.

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ization, primary methods of operation would require a sharp increase in gas production and that, although larger amounts of plant liquid would be available, there would be problems of expanding the plant and increasing investments to keep pace with rising gas production. Greater expansion of the plant may be necessary since the owners are considering pressure maintenance by water injection.

Under such operation, production of wet gas and plant liquids could be controlled at steady levels forecast for many years.

Also furnished by the engineering report were determinations of the percentage of the field's oil and gas sand under each tract. These percentages became a basis for ownership participation in the plant.

Midway Field, Arkansas

Production was opened in Midway field, Lafayette County, Arkansas, in January 1942. The field produces from the Smackover lime at a depth of approximately 6,800 ft. The 1,770-acre pool has 46 oil wells and 4 water injection wells.

The natural-gasoline plant serving Midway field has reported an accumulated production of 2.3 million barrels of natural gasoline and products in its first 12 years of operation. This is a total average of 400 bbl. per day. Eleven products are sold. From the time the plant was built in 1944, the field has delivered gas of uniform content to the plant at a nearly constant rate (Fig. 4).

During the first 15 months of field operation, certain unfavorable aspects appeared as to gasoline-plant possibilities in the field. Gas production was relatively small, less than 350 cu. ft. of gas per barrel of oil; and the allowable was due to be cut because of sharp decline in reservoir pressure.

Also, the gas contained a high percentage of nitrogen, and it appeared that outside fuel would be required to serve adequately both field and plant fuel requirements, after shrinkage. However, considerable reservoir data were obtained and it was indicated that the reservoir had substantil thickness, good permeability, and exceptionally high porosity. Estimates were made which revealed that approximately 150 million barrels of stock-tank oil were in place initially.

After intensive reservoir studies and a brief injection trial, the owners agreed on a cooperative program of pressure maintenance by water injection to attempt to recover as much as possible of the oil in place. The graphic results show that pressures has been maintained successfully since 1943 and that, consequently, production rates of oil, gas and plant liquids have been exceptionally constant for more than 12 years.

On February 1, 1956, the field was unitized. Testimony at the unitization hearing before the Arkansas Oil and Gas Conservation Commission indicated that over one-half of the presently estimated ultimate recovery remains.[10]

Reservoir Engineering

The foregoing field examples include only a few of the many combinations of complex reservoir performance that may be encountered every day when gasoline-plant prospects are examined. Reservoir engineering methods of proved reliability are now available to make reasonably accurate forecasts.

As reliable forecasts are needed, the first requirement is to obtain the necessary data from the wells drilled, including cores, core analyses, and well logs. Reliable measurements of pressure and production are required, also a complete geological engineering study.

Samples of reservoir fluids are to be

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These features, plus Manhattan's oil-proof tube which permits drilling-in with oil or oil-base mud, add up to easier handling and longer, trouble-free service at less cost for all methods of drilling. Write for Bulletin #6743 for details of how you can get the highest safety factor, longest life and lowest cost per foot drilled . . . "More Use per Dollar" . . . with Ray-Man CBL Rotary Hose.

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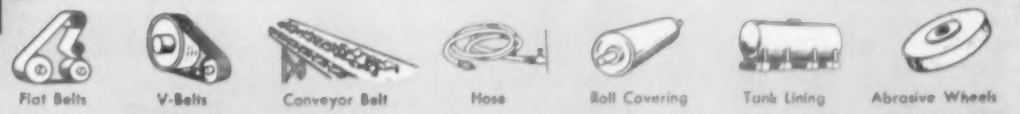

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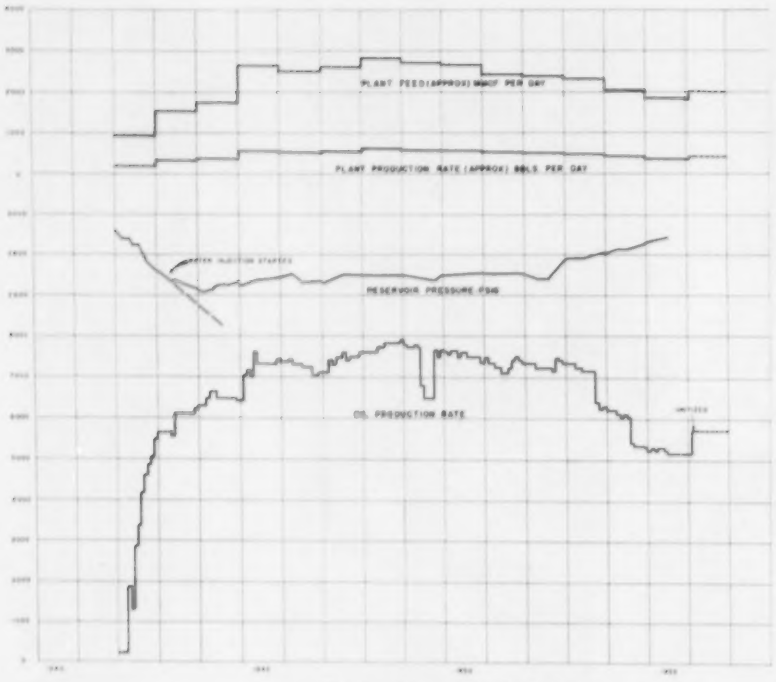

(Data from Arkansas Oil & Gas Commission)

Fig. 4—Midway field, Arkansas, field performance and approximate natural-gas liquid production.

Symposium

taken at appropriate points throughout the reservoir, using subsurface samples or separator samples as required. The entire program of obtaining reservoir data is to be designed for advanced reservoir engineering so that it would be possible to make thorough studies if desired.

The term "formation evaluation" is proposed[11] for the gathering of physical data on the formation, its fluids, and its distribution within the formation so that the essential information is available for developing and operating the reservoir and for serving the plant projects.

Reservoir testing . . . The vital data from wells drilled are obtained by coring, logging, and testing. A program planned through engineering assures complete and representative information with the least amount of time and expenses.

Based on comparison of core-analysis data and the initial logs in key wells, a program is designed for routine logging and coring. With such a program, formation tests are recommended to confirm the position and extent of the producible fluids. Forecasts for plants are made early in the life of any field. When there is a scarcity of pool performance data, the scarcity adds to the importance of formation measurements. Also required measurements of reservoir pressures, temperatures, and well behavior including pressure buildups and interference tests, when appropriate. Geological and engineering studies of the producing field and surrounding areas are very important.

Computations . . . Reservoir-engineering computations involve analysis and projections. The analysis based on formation and performance data show how much oil is in place and how the hydrocarbons are distributed throughout the reservoir, the geometry of the reservoir and, finally, the changes that have occurred in reservoir pressure and fluid content.

The economic projections include schedules of investment cost and operating expenses that are applied to forecasts of production under various operating methods. Knowledge of the probable operating method, therefore, is a requirement in making forecasts of wet-gas production.

The composition of wet gas can be estimated through additional calculations, usually a flash liberation in field separators and differential and stepwise flash liberation within the reservoirs.

When justified by the use intended, special laboratory research provides experimental data that improve the reliability of present-day gas-phase reservoir calculations.

Advances . . . The present principles of reservoir engineering were becoming available from research when Matheny wrote his N.G.A.A. paper in 1944. Advances since that time have been mainly in the application of those principles toward more recovery and in development of engineering methods of analysis. Highlights of these developments appear to be in the following:

1. Recognition and application of water injection for pressure maintenance, introduced in 1943.
2. Developments in special cases of gas injection, high pressure, vaporization and condensing drives.
3. Recognition of and improvements in formation evaluation including logging developments and special core analysis.
4. Development of practical methods to apply complex principles to reservoir analysis and forecasts including calculations on gas composition, gravity drainage and displacement.[12]
5. Rapid growth of injection projects and field-wide units to increase recovery.

The developments in reservoir engineering provide powerful tools that can eliminate most of the guess work as to supply on the question of "to build or not to build a gasoline plant."

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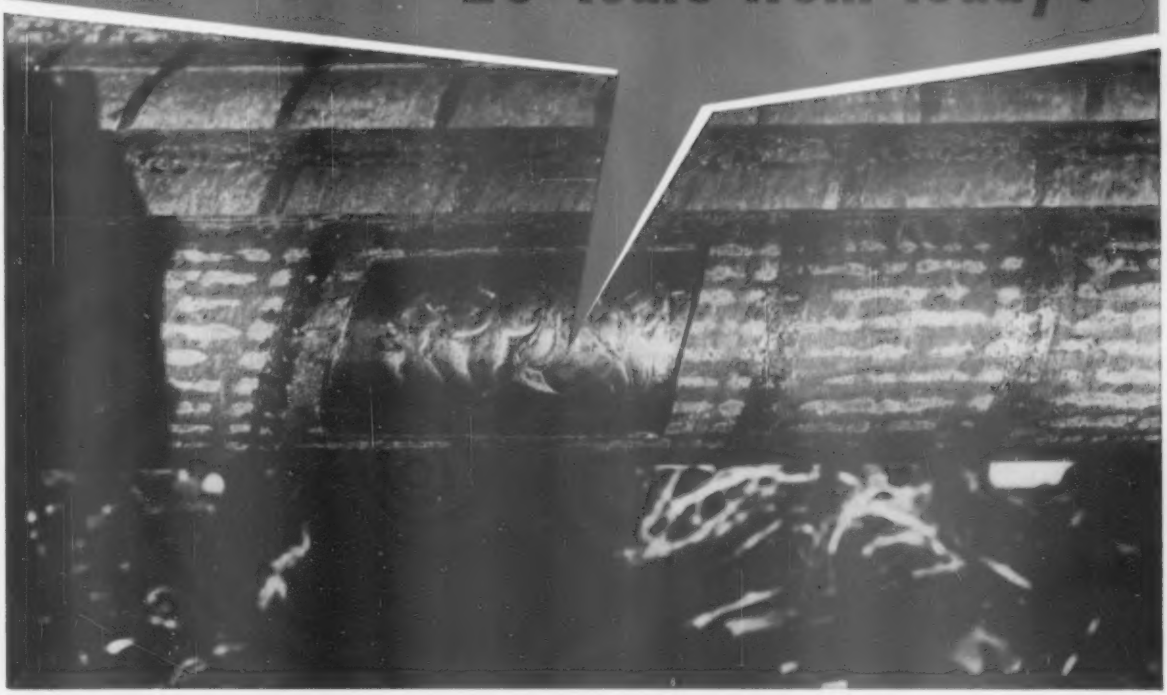

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The Podbielniak Institute has been founded by Dr. and Mrs. Walter J. Podbielniak as a self-sustaining, but essentially non-profit institution, to make available to the industries special instruction and training courses in analysis of gases and vaporizable liquids.

The idea for such a training school was first inspired in 1952 at the time the Natural Gasoline Association of America had completed a series of comparative analytical accuracy surveys, starting in 1940, on natural gas and gasoline samples in which over 100 industrial laboratories had cooperated for purposes of standardization and improvement of analytical techniques.

As a result of these studies, a special analysts' training school was conducted at the University of Oklahoma in which analysts were trained during a nine-month period. Light hydrocarbon physical constants, conversion and calculation methods were standardized and improved, efficient and accurate analytical techniques were evolved and taught with resulting substantial improvement in industry-wide accuracy as established by later cooperative synthetic sample testing surveys.

Accordingly, in order to continue and extend this type of training in techniques and exchange of knowledge, the Podbielniak Institute is now offering a special intensive two-week course intended primarily for qualified industry personnel, at the former location of the Illinois Institute of Design Building at 632 North Dearborn Street, Chicago 10, Illinois, with complete facilities for lectures and demonstrations of latest apparatus and techniques.

The course will cover special instruction in the analysis of natural gas and gasoline, petroleum and its products as produced by refining and petrochemical processes, and similar complex gases and vaporizable liquid mixtures using latest apparatus and techniques, such as low and high-temperature analytical distillation, vapor-phase chromatographic and other supplemental methods.

It is planned that, in time, the Podbielniak Institute will serve in the capacity of a central reference and clearing house for exchange of information and best practices in the methods used for the analysis of gases and vaporizable liquids. It is further intended to study problems, and cooperate with analysts in the development of best use of apparatus and techniques to the fullest extent for the benefit of industry.

As this program is expanded and the Institute grows, other courses and services will be offered in the broad field of counter-current contacting processes, including solvent extraction and special problems in their application to plant production.

In further cooperation with industry, only a portion of the building will be devoted to the school, using the lecture hall and adjacent laboratory rooms. The balance of the building, including an auditorium with a seating capacity of approximately 250 people will be made available to engineering societies for their monthly meetings, or as their headquarters on a self-sustaining non-profit basis.

Two new instruments developed to aid in

Analyzing Hydrocarbon Mixtures

1. New thermal conductivity cell for distillation equipment
2. Vapor-phase chromatographic equipment

by W. J. Podbielniak and S. T. Preston

TWO new types of apparatus have been developed recently, in answer to the need of the natural-gasoline and associated industries for greater accuracy in hydrocarbon analysis:

• Conventional low-temperature distillation equipment has been greatly improved by the substitution of a thermal conductivity cell for the usual fine-wire thermocouple junction in the reflux.

This means substantial reduction in holdup, and increased accuracy with smaller samples.

• Vapor-phase chromatographic equipment is now available for hydrocarbon analysis. Separation of components is accomplished by passing a sample through columns packed with solid adsorbents or selective solvents. Analysis is based on thermal-conductivity response, and is fast and accurate.

Why such accuracy? . . . The natural-gasoline industry requires analytical accuracies of high order, 0.1 per cent or better. This is true because the industry separates individual light hydrocarbons from each other—rather than indistinct complex fractions, as in many other industries. These have widely different properties, cannot be slopped over from one specification product to another, and thus must be accounted for precisely, hydrocarbon by hydrocarbon.

Also, these hydrocarbons are immune to chemical separation, and require columns over 100 plates—plant or laboratory— for even partial separation by distillation.

Finally, many important materials, such as wet and dry natural gas, unstabilized natural gasoline, contain the whole range of hydrocarbons, from methane to octane, with their naturally occurring isomers, further complicating the problem of their analysis.

Authors are with Podbielniak, Inc., Chicago. Paper presented at annual meeting, Natural Gasoline Association of America, Fort Worth, April 11-13.

Low-Temperature Distillation

Low-temperature fractional distillation analysis was hailed with joy, when it first became available many years ago, because it handled the entire hydrocarbon range in one apparatus and general technique, and in good hands could yield accuracies approaching the desirable 0.1 per cent although with some difficulty on isomers.

However, it was gradually realized that the accuracies which can be obtained in a model laboratory with a properly designed and constructed apparatus with research-grade analysts completely familiar with the theory and technique of the method, were not necessarily duplicated on an industry-wide basis.

The discrepancy was aggravated by a diversity of specific apparatus constructions in many natural-gasoline laboratories, equally great differences in operating techniques, lack of standardization of physical constants and calculation procedures, etc.

N.G.A.A. Standardization

The Natural Gasoline Association of America, through its technical committee, was quick to appreciate this situation and to organize cooperative interindustry testing surveys.

Phillips Petroleum Co. was encouraged to make available synthetic hydro-

Announcing . . . Podbielniak Institute

THE ADVANTAGES of special training in hydrocarbon analysis have been so manifest that recently, with the encouragement of the N.G.A.A., the Podbielniak Institute, 632 North Dearborn Street, Chicago, was founded. The institute, a nonprofit, self-sustaining organization, will offer training in analytical distillation and in vapor-phase chromatography. Two-week courses wll be given five times a year, beginning on September 15, 1956.

Field Processing

carbon samples of exactly known composition. The analyses on such samples submitted by over 100 cooperating laboratories were correlated and examined, physical constants and calculating procedures were standardized.

Finally, industry analysts themselves were trained in latest techniques at the N.G.A.A. special school at University of Oklahoma, Norman, from September 1952 to June 1953.

As a result of this work, there has been substantial improvement in general analytical accuracy within the natural-gasoline industry.

As a result of the findings of the cooperative testing surveys, a regular crusade was organized against "causes of errors," whether due to human element, incorrect analytical technique, or to design, construction, and maintenance of apparatus.

1. . . . The Thermocon

Improved equipment has been designed, and a new type of low-temperature distillation apparatus is now available. This unit, the Thermocon, is perhaps typical of the latest developments of the low-temperature distillation method of analyzing light hydrocarbons.

The principal feature of the apparatus is the use of a special thermal conductivity cell to trace the composition change of vapor distillate from the top of the column, rather than relying on the usual fine-wire thermocouple junction, in the reflux.

The greatest single cause of errors in low-temperature distillation analysis is the uncertain holdup of liquid around and above the reflux thermocouple junction. This varies from about 20 to 65 gas cc. depending on component, column operating conditions, etc. Therefore it is necessary to take samples large enough, so that the error introduced by this holdup uncertainty would be reduced as much as desired. However, large samples mean a longer distillation time.

The thermal conductivity cell, diagrammatically represented in Fig. 1, eliminates this trouble. Whereas the thermocouple must be inserted within the refluxing zone at top of column, the thermal conductivity cell senses the distillate vapor at room temperature (no condensate!) just before the expansion valve to the receiving bottles.

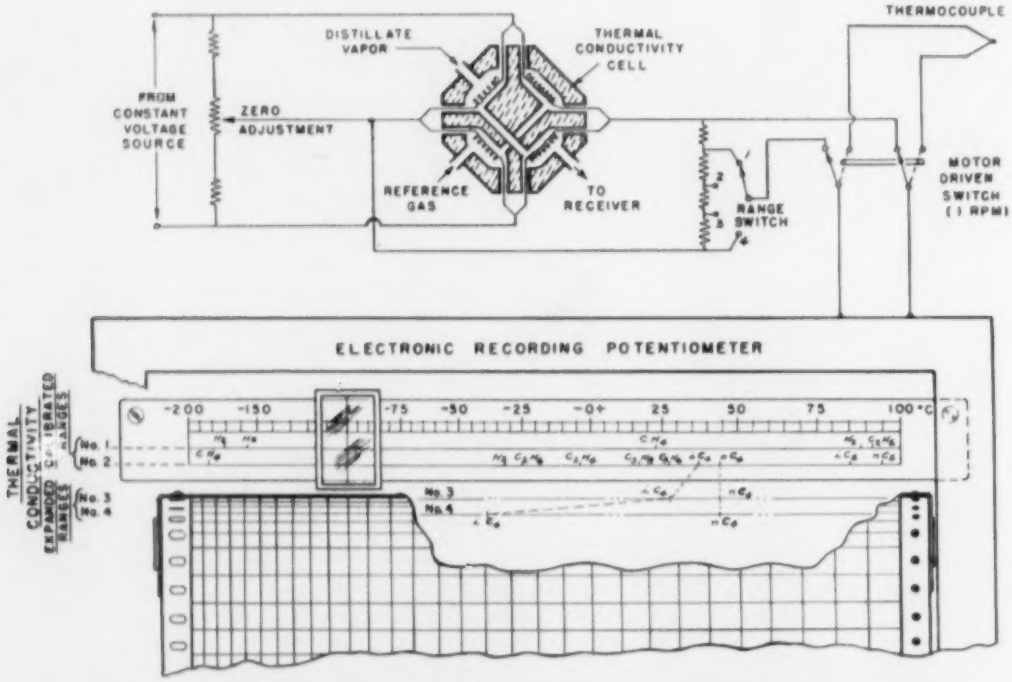
The holdup of vapor in the cell is only about 0.5 cc. which compares with the uncertainty between 20 and 65 gas cc. around the thermocouple. Further, the thermal conductivity cell is far more sentive than the thermocouple, as evidenced by the expanded scales shown in Fig. 1.

Its indication is only very slightly affected by pressure variations in the column, and is more nearly linear with composition. Because of the position of the thermal conductivity cell, the "pipeline" vapor holdup between the cell and the expansion value is almost completely eliminated.

There were many difficult problems involved in developing the final cell. The cell had to have a quick response to changing distillate stream composition, but it also had to be completely flow insensitive, from 0 to perhaps 200 cc. per minute distillate vapor flow.

It had to be extremely stable, so that several scales of various sensitivities could be standardized, per Fig. 1. It had to be thermostatted. Finally, and most important for optimum performance it had to be protected against violent surges or changes in the distillate stream flow rate, as possible with the previously used automatic distillate rate control.

"Electronic brain" rate control . . . Accordingly, a so-called "electronic brain" distillate rate control was developed, not only to help the thermal conductivity cell indicate changing composition more faithfully, but also to improve the previous automatic rate control device (Fig. 2). These depended on single thermocouple indication of reflux



RECORDING and multiple scale system for the Thermocon low-temperature distillation unit. Fig. 1.

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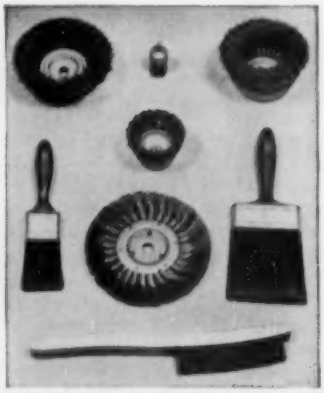

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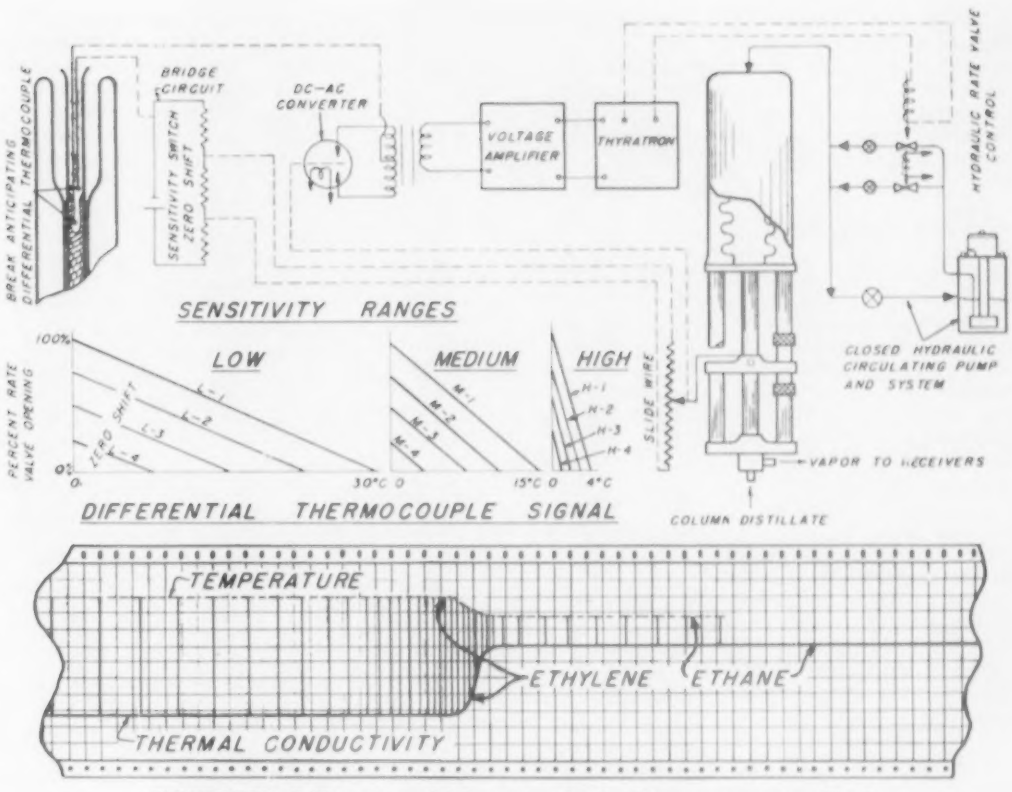


ELECTRONIC distillate-rate modulating system for the Thermocon apparatus. Fig. 2.

Field Processing

temperature rise, plus sudden pressure drops in column typical of approaching "breaks."

The electronic-brain control, uses, instead, the **difference** in temperature between top of packing and a point 2 or 3 in. below; this **anticipates** a break, before it even reaches the top of the column, is far more sensitive, and makes possible proportioning type control of rate. As a result, an operator can now actually let the Thermocon perform for itself, all the way from the time of first establishing stable distilling conditions on methane, up to n-butane, when the apparatus will call for a pressure change.

Other improvements . . . The incorporation of thermal conductivity measurements into the apparatus necessitated streamlining throughout, to realize completely the greater accuracy and speed. The receiver manometer was improved by decreasing the bore, thereby permitting the rapid calculation of gas volumes in any size receiver, without the use of complicated correction procedures.

Various size receivers are used including receivers of one liter capacity and less, as required for the precise measurement of components when analyzing small samples. The receivers are thermostatted at a fixed temperature precisely controlled by means of a mercury in glass thermoregulator.

Performance . . . The improvement in accuracy, which has been demonstrated with the Thermocon, is significant, even for very small samples. L.P.G. samples of from 100 to 200 cc. of gas, can be analyzed in about 1 hour with an accuracy of 0.1 to 0.2 per cent.

Natural-gas samples as exemplified by the gas sample used in the N.G.A.A. cooperative testing program during 1955, can be analyzed to an accuracy representing 0.04 to 0.10 per cent average deviation per component. Natural-gasoline samples, being somewhat more difficult to analyze, may be determined to an average deviation of 0.1 to 0.2 per cent per component.

The improvements in the Thermocon have materially decreased the time and attention required of an operator. The electronic-brain control of the Thermocon is flexible to the point where it need be given general adjustments only, to run a distillation

PACKAGED UNIT is the Thermocon automatic recording low-temperature distillation analysis apparatus. Fig. 3.

either for maximum accuracy, or for high speed, with reduced size samples.

The automatic rate control not only serves to anticipate "breaks," and reduce rate accordingly but will also automatically correct minor disturbances in column operating conditions, and stop the distillation in case of a major disturbance. The constant reproducibility of results obtained with the Thermocon may be attributed to identification by thermal conductivity and to the virtual elimination of human control over the distillation.

2. . . . The Chromacon

The basic design of the Chromacon (vapor-phase chromatographic equipment) is shown diagramatically in Fig. 4. Separation of components is accomplished by elution of the sample through columns packed with solid adsorbents or nonvolatile liquids dispersed on an inert porous solid. Detection of the components in the column effluent is accomplished by continuous recording of the thermal conductivity of the gas.

The time required for a component to traverse the length of the column serves to identify the component, while the magnitude of the thermal conductivity responses (peak height) is directly related to the quantity of the material present. The completely assembled apparatus is shown in photo Fig. 5.

Applications

The separation, identification, and quantitative determination of practically every hydrocarbon from methane to decane has been accomplished, including isomers, olefins, diolefins, and aromatics.

Of specific interest to those engaged in the natural-gasoline industry is the applicability of the Chromacon to the analysis of natural gases, liquefied petrolem gases, and natural gasolines.

Natural gas . . . Techniques are now fully developed for the analysis of natural gases for all components from methane to pentane and higher. Separation of the light hydrocarbons may be accomplished by selective adsorption or solution, using samples of from 1.0 to 15.0 cc. of gas.

A partition column can be used to separate the components boiling above ethane, but due to the low solubility of methane and ethane in all stationary phase liquids, special operating techniques have been developed to permit analysis of wide-boiling-point mixtures.

The separation and quantitative determination of methane and ethane, in mixtures of high-boiling hydrocarbons can be accomplished by using long columns, refrigerated columns, or by operating with the columns under pressure. Combinations of partition and adsorption columns are of course possible and may be used in spite of the added complications.

Dry natural or plant gases containing small concentrations of butane are easily analyzed and techniques are available to permit analysis to a fairly high accuracy, for one key component, as butanes.

Wet natural gases may be analyzed by the method but present a problem in the method of computing the concentration of pentanes plus, since this fraction will be split into all of the individual components.

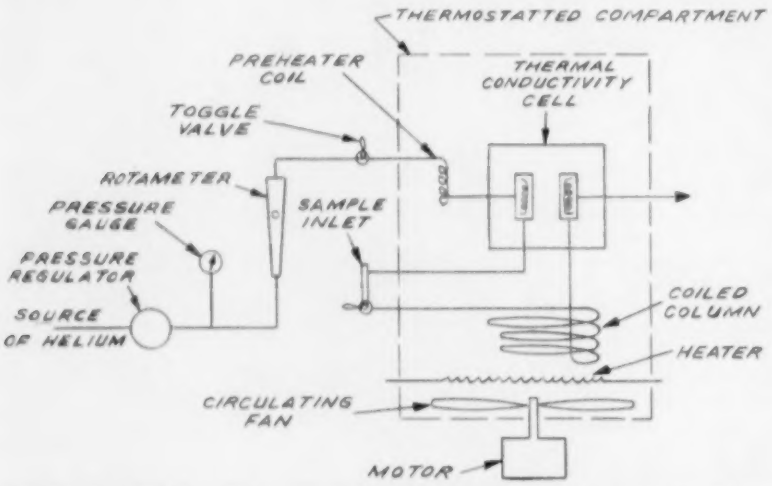
Two approaches are available to circumvent this difficulty, namely, (1) to charge fixed-volume samples, determining the pentanes plus by difference and (2) to combine peak heights of the pentanes and heavier components, making use of suitable calibration constants.

The accuracy obtainable in the analysis of natural gas samples, has not been thoroughly evaluated, but is probably 1 to 4 per cent of the concentration of the component.

L.P.G. . . . These samples are among the easiest to analyze by vapor-phase chromatography and present little or no difficulty even if the sample contains hydrogen sulfide or mercaptans, water, or includes olefins. Stainless-steel columns and detector cells are available for the analysis of any corrosive gases.

Special stationary phases have been found for the separation of water or olefins. The method is ideally suited to the determination of the concentration of a front end contaminant as ethane in a propane product. A typical chromatogram is shown in Fig. 6.

Natural gasolines . . . In addition to the problem mentioned under "wet" gases, of how to compute the pentanes plus content, from a complete chromatogram of a natural gasoline, there is considerable difficulty in obtaining a representative sample of high-vapor-pressure liquids unless the material may be completely vaporized before the sample is taken. Special designs for



SCHEMATIC DIAGRAM, Chromacon vapor-phase chromatographic apparatus. Fig. 4.

CHROMACON vapor-phase chromatography apparatus. Fig. 5.

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Gray Wolfe — Pinehurst, Texas

1948

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Warren — Mobile, Alabama
Lion — Shuler, Arkansas
Gulf — Kiefer, Oklahoma
Wehlu — Edmond, Oklahoma
Barnsdall — McFaddin, Texas

1949

Texas Co. — Archer City, Texas
Baldridge & King — San Pablo, Texas
Lion — Shuler, Arkansas
Barnsdall — Placedo, Texas
Barnsdall & Sterling — Bloomington, Texas
Reno Oil Co. — Geraldine, Texas

1950

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Del Rey — Chesterville, Texas
Mid-Valley — Clarkson, Ky.
Pecos — Orla, Texas
Humble — South Mayes, Texas

1951

Pan American — Willamar, Texas
General Crude — Dayton, Texas
T G T — East Bernard, Texas
Texas Co. — Snyder, Texas
Del Rey — Chesterville, Texas
Sunray — Placedo, Texas

1952

Mid-Valley — Clarkson, Ky.
General Crude — Claremont, Texas
El Paso Natural — Orla, Texas
T G T — East Bernard, Texas
T G T — Victoria, Texas
Humble — South Mayes, Texas
Texas Co. — Snyder, Texas
Del Rey — Chesterville, Texas
Shell — Gohlke, Texas

1953

Humble — Trawick, Texas
Texas Co. — Paradis, Louisiana
Sacroc — Snyder, Texas
Tennessee Production — Banquete, Texas
Tennessee Production — Chesterville, Texas
Warren — Fairbanks, Texas
El Paso Natural — Orla, Texas

1954

Sunray — Ingleside, Texas
T G T — Fostoria, Texas
Magnolia — Pegasus, Texas
Texas Gulf Producing — Odessa, Texas
General Crude — Clairemont, Texas
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Tennessee Production — Chesterville, Texas

1955

Murmanill — Fairbanks, Texas
Sharon Ridge Canyon Unit—Snyder, Texas
American Republics — Silsbee, Texas
T G T — Isola, Mississippi
T G T — San Salvador, Texas
Shell — Iowa, Louisiana
O & G P M — Old Ocean, Texas
Humble — Pita Field, Texas
Kimball Gas Products — Kimball, Neb.

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T G T — La Porte, Texas
Texas Co. — Tampa, Florida
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Humble — Refugio, Texas

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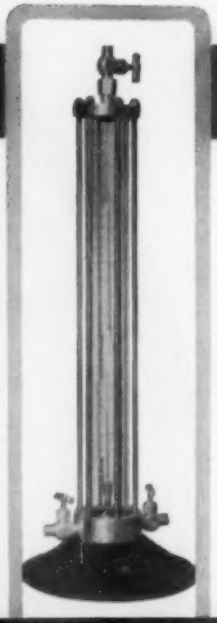

For obtaining specific gravity of liquefied petroleum gases, such as propane and butane, which under normal atmospheric pressure would evaporate into a gaseous form. Jar withstands operating pressures of 200 psi at normal temperatures. Equipment consist of clear lucite tube, aluminum end caps held by tie-rods and a conical base. Three needle valves allow entry of the sample and adjustment of the liquid level.

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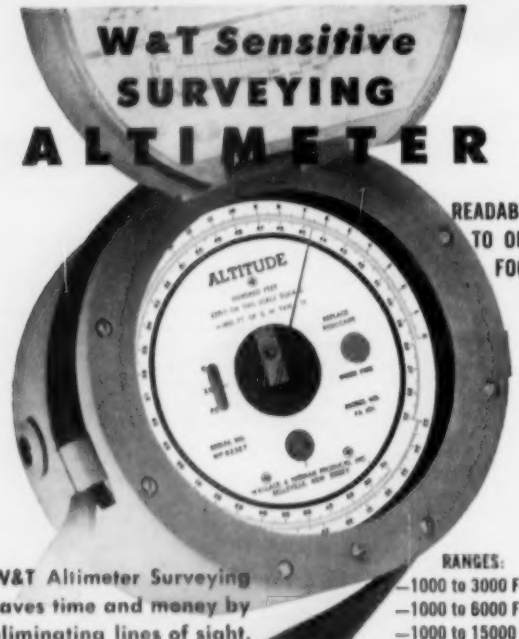

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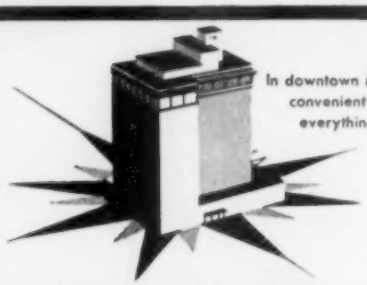

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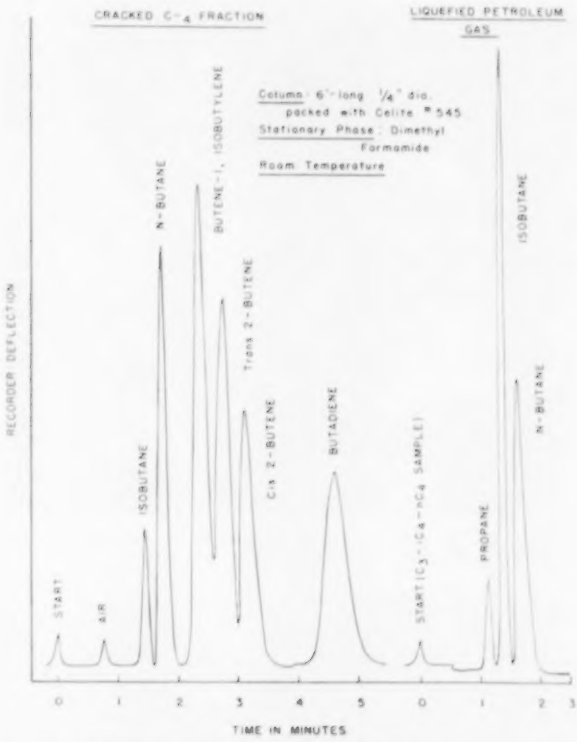
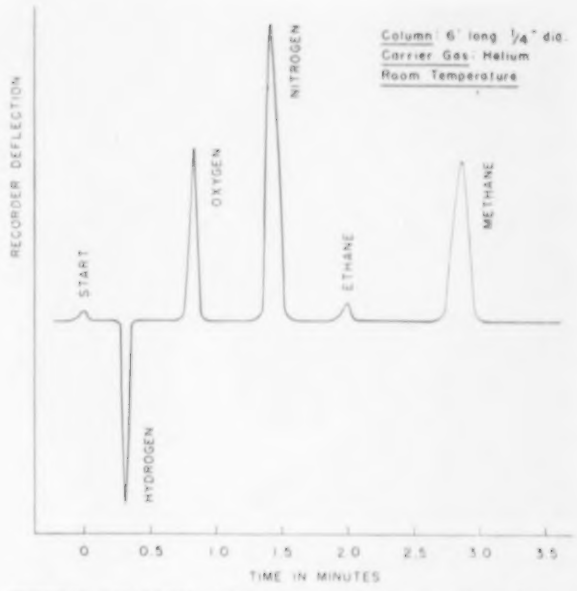


PROPANE AND BUTANE analysis by vapor-phase chromatography. Fig. 6.



TYPICAL ANALYSIS of fixed gas mixture by vapor-phase chromatography. Fig. 7.

the sample introduction system are being tested to meet this challenge.

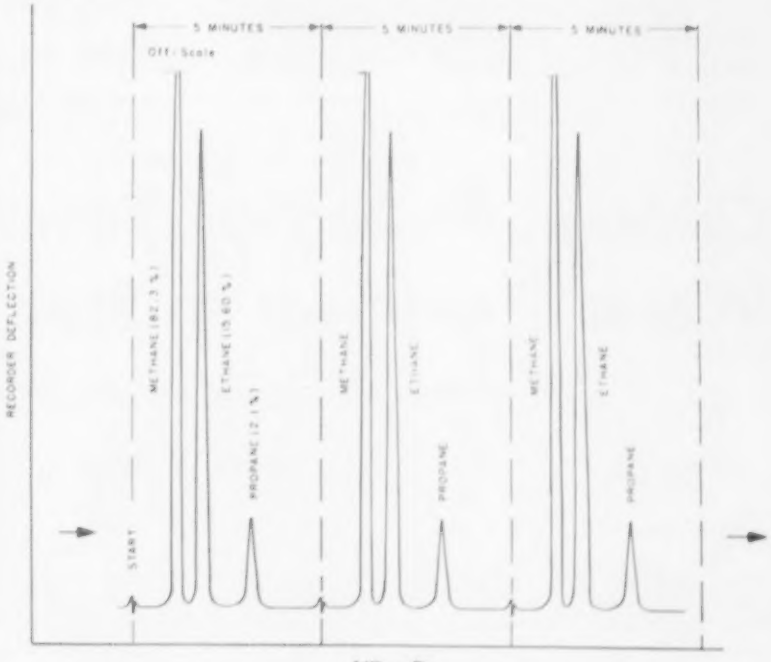
The analysis of mixtures of hydrogen, nitrogen, oxygen, carbon monoxide, carbon dioxide, methane, ethane, etc. is easily accomplished using either adsorption columns or special techniques with partition columns. A typical chromatogram is shown in Fig. 7.

Continuous stream analyzers . . . With almost the first reports on successful analyses with vapor-phase chromatography, the question was raised concerning its possibilities for plant process stream monitoring or control. While the basic chromatographic separation process is inherently cyclic, the time element is so short, that continuous cyclic monitoring by this principle has always seemed feasible.

Equipment to do this job has been developed by Podbielniak, Inc. A typical chromatogram obtained with this model is shown in Fig. 8. The time required per analysis is fixed by the retention time of the last component to be eluted, but can be adjusted to 2 or 5 minutes by proper selection of column packing and operating conditions.

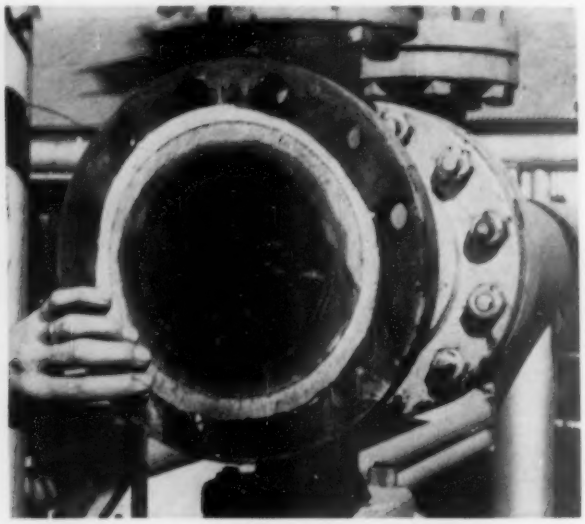
The short time per analysis makes this method of operation practically continuous, and it is adaptable to the analysis of any stream (plant or field) where a continuous record of composition is required. This new model is completely flexible in design, i.e., can be adapted for the analysis of practically any gaseous mixture, repeating the analysis at any desired interval down to about 2 minutes, for the cyclic analysis of one or more plant streams.

For example, in a natural-gasoline plant, it would be advantageous to gather samples from important sampling points, as inlet gas, absorber, deethanizer, and depropanizer column top gases, etc., for cyclic analysis, every 30 minutes or so. Such an arrangement has the special advantages of relatively low cost, simplicity of principle and apparatus, easy maintenance, and great flexibility.



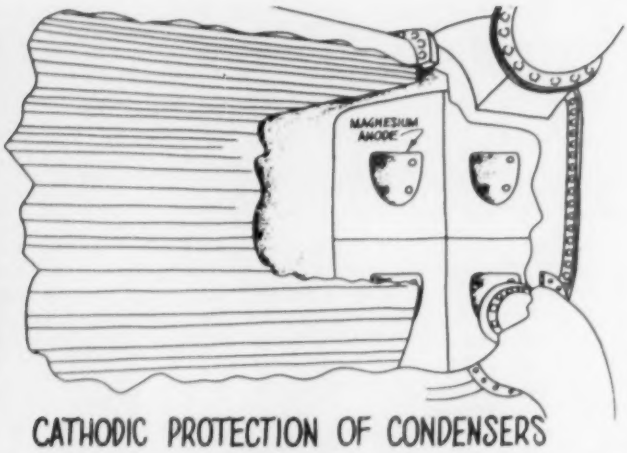
AUTOMATIC ANALYSIS of residue absorber gas (cyclic basis). Fig. 8.

FLOATING HEAD from a still overhead condenser showing heavy tubercular scale buildup. Fig. 1.



SCALE ACCUMULATION in the channel of a small two-pass cooler. Fig. 2.

THREE 2-lb. neoprene-coated magnesium anodes installed in the channel cover of a three-pass condenser. Fig. 3a.



TYPICAL magnesium installation on channel cover of a condenser. A sized hole cut in coating determines current output. Fig. 3b.

Cathodic Protection Teams Up With Water Treatment to Stop Corrosion

. . . the pair gives good results on water side of equipment

by M. J. Olive

ARKANSAS FUEL OIL CORP is mitigating corrosion in its East Texas gasoline plant by combining cathodic protection with water treatment. These results were found in a series of tests to combat corrosion of equipment on the water side in the Greggton, Tex., plant:

- In water systems containing large amounts of minerals and corrosion products, dianodic treatment is not sufficient to prevent corrosion and scale accumulation in channels, tube sheets, and floating heads.
- Cathodic protection will offer good corrosion protection and scale prevention in locations where water treatment is not sufficient.
- Magnesium anodes offer the best solution since they are inexpensive and can be obtained in small and specific shapes.
- Restrictions of anode output is best achieved by coating the anodes

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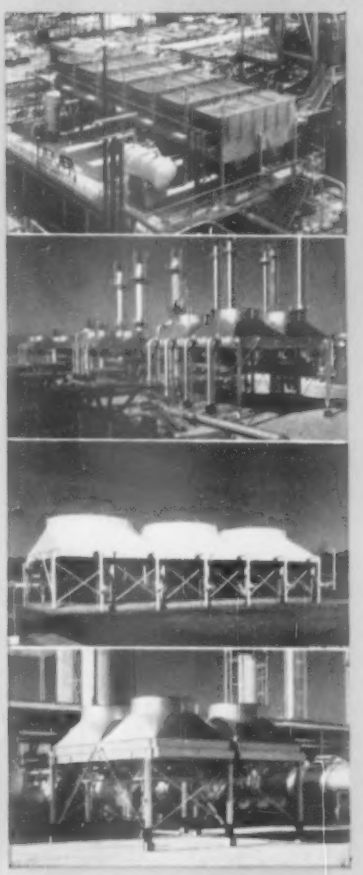

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Solo-aire Units, installed in space formerly occupied by water box submerged coolers, are used for condensing and oil cooling, eliminating water circulation of 4200 gallons per minute. Previous high maintenance costs due to water scaling and corrosion are also eliminated.

GAS PROCESSING PLANTS

Solo-aire Units as pictured at left, and Combin-aire Units, are minimizing water consumption, lowering water treatment costs, and lowering over-all maintenance expense in scores of Gas Processing Plants in the United States, Europe, Pakistan and South America.

COMPRESSOR STATIONS

Solo-aire Units are installed in many of the larger main line Compressor Stations in the United States for cooling gas, jacket water, and lube oil. HUDSON auto-variable pitch fans allowing accurate, automatic control of cooler outlet temperature are used in many of these installations.

CHEMICAL PLANTS

Vapor at 550°F. is condensed and condensate subcooled in Solo-aire pictured at left. In services for cooling of very high temperature fluids, and cooling of fluids with which water contamination must be avoided, Solo-aires are particularly adapted.

Experience The first HUDSON exchangers using air as the cooling medium were installed over 20 years ago for condensing exhaust steam. Thru constant research, improvement and innovation in design and in manufacturing techniques, and in development of units for special applications, HUDSON reached and has retained its position of leadership in "Cooling with Air."

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OVER 200 AUTO-VARIABLE PITCH FANS are providing accurate, trouble-free temperature control in Hudson Solo-aire and Combin-aire units. Minute changes in cooled fluid outlet temperature immediately and automatically changes pitch of fan blades, increasing or decreasing flow. Control is effective despite changes in heat load or hot fluid inlet temperature; and over ambient air temperature range of more than 150° F.

Consult Hudson for more detailed information on the application of Auto-variable pitch fans to present or future installations.

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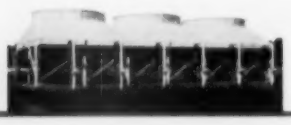
- **Accurately control temperature.**
- **Effect major savings in power.**
- **Reduce cost of control equipment.**
- **Eliminate by-pass piping.**
- **Prevent freezing even in extremely cold weather.**
- **Operate with standard pneumatic instruments.**
- **Have all moving parts of control mechanism completely enclosed and weather-proofed.**



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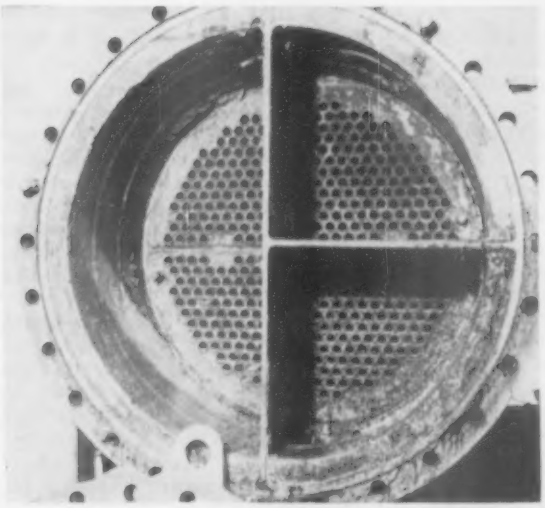

CHANNEL of the depropanizer reflux condenser after 4 months of operation with cathodic protection installed. There was no scale buildup and no apparent additional pitting. Fig. 4.

ANODE INSTALLATION on the channel cover of depropanizer reflux condenser after 4 months of use. The neoprene coating blistered and failed in many points. The magnesium has been eaten away under each hole. Fig. 5.

Field Processing

and sizing the output holes. A dipped neoprene coating is not sufficient. Anodes with polyvinyl chloride coating are available, and experience indicates that this coating is suitable for this application.

- A current density of better than 10 ma. per sq. ft. is needed in most systems.
- The most economical approach to corrosion and scale control is anodes in conjunction with a good water treatment.

Three areas . . . There are three general locations in gasoline plants where special preventive measures are critically needed for corrosion mitigation. The first is external corrosion of underground piping and tank bottoms. This can be controlled by applying cathodic protection using rectifiers and distributed magnesium anodes. The second is internal corrosion on the product side of process equipment. This is treated by the use of corrosion inhibitors in conjunction with special alloys.

The third is internal corrosion of equipment on the water side. This type of corrosion attack will be covered in some detail in this article.

New tests . . . Arkansas Fuel Co.'s Greggton plant was the site of experimenting with a new wrinkle of an old theory of corrosion mitigation—that is, combining cathodic protection with water treatment.

In the early part of 1955, the regular semiannual cleaning and inspection program indicated that the treating of the cooling water by the dichromate method was not adequate for the prevention of corrosion and scale. It was noted in these inspections that pit depths and over-all metal losses were increasing to a point that, unless additional preventive measures were provided, costly replacements would occur.

The attack was largely on the channels, tube sheets, and floating heads. Also, as important as the metal losses was the restriction of cooling-water flow caused by corrosion products being deposited in and around the tube sheets. This resulted in poor heat transfer. This can be seen in Fig. 1, which is the floating head from a still overhead condenser. Note the tube impressions in the scale near the upper side of the divider.

Fig. 2 shows the same buildup in a channel of a smaller cooler. This deposit necessitated many condensers and coolers having to be cleaned every 2 to 3 months, causing large maintenance expenses and unnecessary shutdowns of process equipment. The scale is tubercular, mushy, and red in color, and analyzes to be iron and calcium with small amount of copper and silicates (see Table 1).

Cooling water . . . The cooling water has a resistivity of less than 100 ohms./cm.^{3} and contains large amounts of chlorides, chromates, and phosphates, as shown in Table 2. The cooling-water system also contains relatively large amounts of decayed organic matter and insoluble silicates, and it is a major operation to clear the system thoroughly without a complete shutdown or installations of additional filter systems. The water treatment, then, was changed from dichromate to dianodic with pH controlled between 6.0 and 6.5.

The dianodic method generally is a combination of two basic anodic compounds, phosphate-chromate. The combination of these two inhibitors gives better results than either one used separately. Inspections showed that this treatment was far more effective than the dichromate method. However, due to the heavy concentration of impurities in the cooling water, large amounts of corrosion products were still being deposited in the locations where there was a drop in velocity, particularly in the channel and floating heads of condensers.

This deposit caused the chromates and phosphates to coat the rust tubercular rather than penetrating to the metal surface, as indicated by the fact that the outside layer of rust was greenish yellow but beneath was red rust. When the corrosion products were removed, deep pits were found over the entire area.

Dual method . . . The solution was then to use some method which could be used in conjunction with dianodic

THE AUTHOR

M. J. Olive is chief corrosion engineer of Arkansas Fuel Oil Corp., in Shreveport, La. He graduated from Alabama Polytechnic Institute in 1948 with a degree in chemical engineering and joined Arkansas Fuel Oil immediately thereafter. He is chairman of subcommittee T-2B-1, National Association of Corrosion Engineers, and a member of various other technical committees. Olive presented this paper at the annual meeting, Natural Gasoline Association of America, Fort Worth, April 11-13.

water treatment. Since both corrosion mitigation and detergent action were needed, the corrosion section felt that cathodic protection could be used successfully. A study was made to determine what method could be best used to apply cathodic protection currents.

A rectifier system using platinum anodes was considered, but since this necessitated elaborate installations of explosionproof equipment, it was discarded. However, this method does have merit where large areas need to be protected.

Zinc anodes were studied but due to zinc's characteristic of reversing its polarity at elevated temperatures, this was not chosen. It was then decided that magnesium anodes installed in the channels and floating heads would be tested for both corrosion control and scale detergent qualities.

Magnesium Anodes

To determine the effectiveness of these anodes under actual operating conditions, two parallel depropanizer reflux condensers were inspected and cleaned. Magnesium anodes were installed in the channel and floating head of one condenser while the companion condenser was put back in operation after cleaning.

The magnesium anodes were 1-lb. slabs cut from a standard Grade B 17-lb. bare pipeline anode which were drilled and bolted to the channel cover and floating head. After 6 weeks of equal operation, the condensers were again inspected. It was found that the condenser with the anodes had no rust or scale buildup and no apparent additional pitting.

A thin layer of calcareous coating was present on all steel surfaces indicating ample current for cathodic protection. The companion condenser used as a comparison contained the usual scale buildup with some additional light pitting. This indicated that cathodic protection was a practical tool for corrosion and scale control.

The current from the test anode was not controlled and inspection showed a loss of three-fourths of their original weight in the 6-week period. Adjacent to the anodes were heavy deposits of magnesium hydroxide which indicated that the unrestricted anodes generated excessive and wasteful current.

Regulating current . . . The problem now was to regulate the current output permitting a longer and more economical anode life. A current density of 10 ma. per sq. ft. was considered sufficient for corrosion control and scale prevention. Due to the difficulty of regulating the output of the anodes by means of resistors, it was decided that by coating the anodes and regulating the metal exposed, the life of the anode could be controlled.

In brief, the theory was that the magnesium has a constant driving potential and will allow current to flow proportional to the area exposed.

Upon consulting with the magnesium suppliers, it was found that the only coated anodes available were designed for tank bottoms and ship hulls and were too large physically for our use. Therefore, small 2-lb. D-shapped anodes were purchased which are about 4½ by 4½ by 2 in. thick. These were drilled and tapped for easy attaching in the channels of the equipment and then coated with neoprene. Fig. 3 shows the anodes coated and bolted to a channel cover.

Tests run in the laboratory using the existing cooling water as an electrolyte indicated that 1 sq. in. of exposed area would allow between 30-35 ma. output. Based on these tests and published data on the large coated anodes, each anode installed had an exposed area proportionate to the size of the cooler or condenser (see Fig. 3).

These anodes were installed in every condenser in Arkansas Fuel Oil's East

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CONDENSER TUBE CLINIC

Edited by Arthur W. Tracy,
Metallurgical Engineer,
The American Brass Company,
Waterbury, Connecticut

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Oil refineries have virtually made ANACONDA Arsenical Admiralty-439 standard for refinery condensers and heat exchangers handling crudes, rerun stocks, cracked products, lubricating oils, and by-products. It is resistant to dezincification and can handle corrosive cooling waters at relatively high temperatures. Another important property is its ability to withstand attack by sulfur compounds resulting from the refining of sour crudes. ANACONDA Ambraloy-927, because of its resistance to dezincification and to pitting corrosion by sea water at relatively high velocities, is sometimes preferred in oil refineries on tidewater.

Marine users generally find ANACONDA Arsenical Admiralty-439 satisfactory for inland-water vessels and also for seagoing vessels where service conditions are moderate; but ANACONDA Ambraloy-927 is preferred for most seagoing vessels. Both alloys are resistant to dezincification under all corrosive conditions found in these services.

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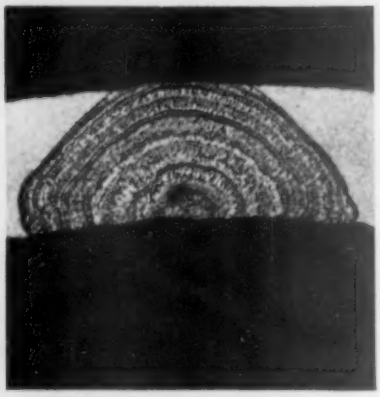
Yield Strength, 0.5% Elongation, psi.	22,000	27,000
Elongation in 2", %	60	55
Rockwell Hardness "B"	6-45	35-65
Density, Lb./cu. in.	0.308	0.301
Thermal Conductivity, B.T.U./Sq. Ft./In./Hr./°F. at 68°F.	768	696
Coefficient of Linear Expansion, Average per °F. (77°-572°F.)	0.0000112	0.0000108

TWO TYPES OF DEZINCIFICATION IN NONARSENICAL CONDENSER TUBES

(approx. 120X)
LAYER-TYPE DEZINCIFICATION on the inner wall of an uninhibited Admiralty metal tube from an oil refinery using polluted fresh water.



(approx. 17X)
PLUG-TYPE DEZINCIFICATION on the inner wall of an uninhibited Admiralty metal condenser tube from a power plant operating on tidewater.

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Texas plant, except those used as blanks to determine how effective the anodes would be.

Inspection results . . . After several months of operation, the anode installations were inspected and photographed. These inspections showed that in each case the anodes were preventing any buildup of scale and no corrosion increase was apparent. A good calcareous coating was being laid down on the metal surface over which was a thin chromate colored coating.

Fig. 4 shows a depropanizer reflux condenser after 4 months of operation. Since it is a four-pass condenser, a 2-lb. anode was installed initially in each section as shown in Fig. 5. Each section has an area of about 6 sq. ft. Four holes were cut, giving a total of 1.5 sq. in. which should give a current flow of 50-60 ma.

After 4 months, the anodes were found to have had a weight loss of slightly more than ½ lb. Calculating the average current output during this period from the weight loss gave a current output of between 80-85 ma. per anode. The difference between the estimate and actual was due to the fact that the neoprene coating blistered badly allowing additional holes through which the current could be dissipated. This can be seen in Fig. 5.

Costs . . . This application of galvanic anodes is economical. For example the depropanizer reflux condensers were being shut down and cleaned as often as every 3 months at a labor cost of $45 per condenser, or $180 per year per condenser. Four 2-lb. anodes were installed on the channel cover and two 2-lb. anodes on the floating head at a cost of $12 plus labor of initially cleaning the channel and installing the anodes.

This installation was $57 for the first year and $30 for the second year. Therefore, a net saving of $123 in labor per condenser for the first year and $150 the second year were realized. This savings multiplied by the total number of coolers and condensers amounted to a sizable saving in labor alone. Table 3 shows a breakdown of the anode cost.

TABLE 1—SCALE FROM THE WATER SIDE OF THE PROPANIZER CONDENSER

Appearance: Fine, dark brown powder.
Analysis: Per cent by weight.

Ash	84.0
Silicates (insoluble in acid)	4.4
Iron and aluminum (as oxide)	34.5
Calcium	52.0
Magnesium	Trace
Sulfates	None
Sulfides	Trace
Copper	Trace

TABLE 2—ANALYSIS OF COOLING WATER

Total hardness	96
$CaCO_3$	68
Magnesium as $CaCO_3$	28
Methyl orange alkanity as $CaCO_3$	62
Sulfates	1,328
Chlorides	2,640
Silica	50
Phosphates	32
Ortha phosphate	13
Chromate	45
pH	6.2

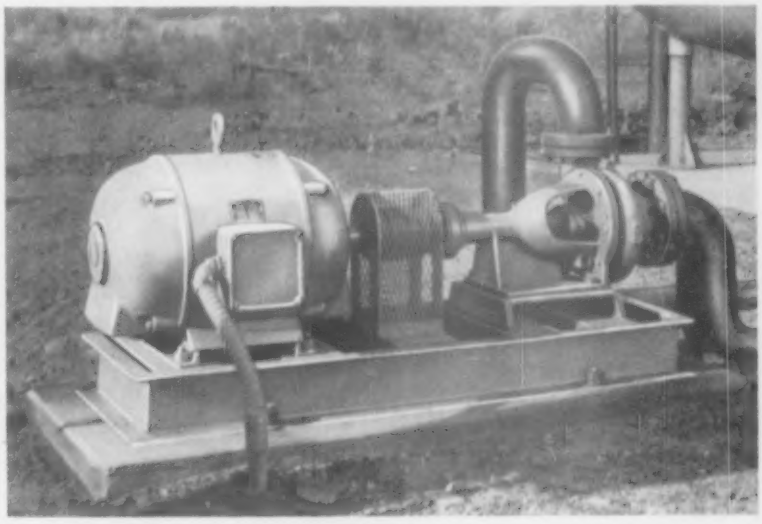
TABLE 3—MATERIAL COST OF MAGNESIUM ANODES USED IN WATER SIDE OF CONDENSERS

2-lb. magnesium anode, drilled and tapped (f.o.b. Houston)	$1.75
Cost of neoprene for coating	0.25
Total material* (per anode)	$2.00
2-lb. magnesium anode coated with PVC (polyvinyl chloride) (f.o.b. Houston)	$3.25

*Labor varies as to the size of condenser, etc.

Acknowledgment

Acknowledgment is given the personnel of the East Texas Gasoline Plant for procuring the data presented in this paper. All photographs were made by J. E. Hampson, Arkansas Fuel Oil Corp.'s photographer.



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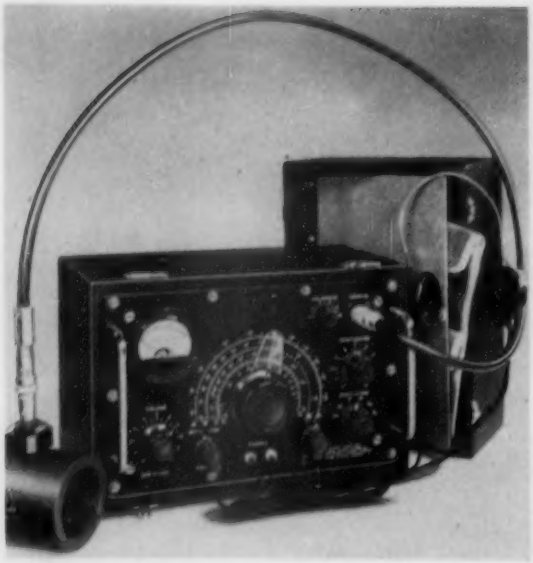
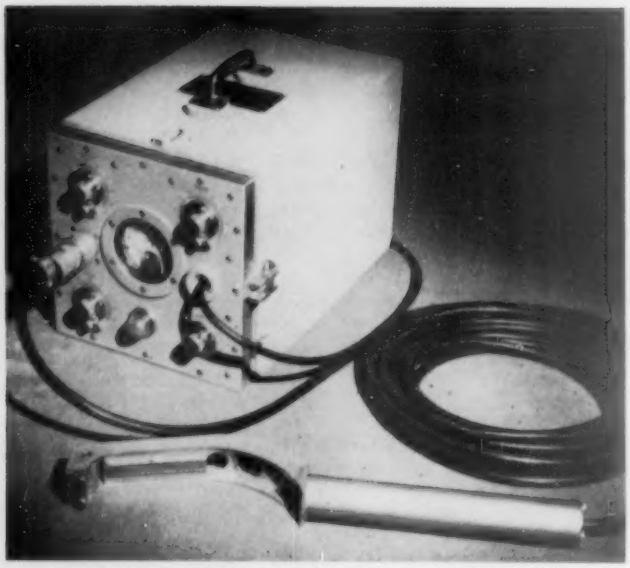


ULTRASONIC INSTRUMENT for nondestructive testing in a natural gasoline plant. Fig. 1.



RADIOACTIVE INSTRUMENT, also used for nondestructive testing, uses 110-volt power supply. Fig. 2.

Corrosion Is Where You Find It

To lick it you must first find it. Here's a blueprint of how to conduct a plant-wide sleuthing program, using tools varying from electronic instruments to plain visual inspection.

by O. L. Gambrell

CORROSION detection and control in gasoline plants and other similar installations is now considered necessary for economic and safety reasons. And a corrosion or "condition" survey program should be included in the operation of these facilities.

The type of program will depend on the individual plant and operating conditions, but generally speaking, the following three-point program will enable the operator to maintain his plant economically and safely:

- Routine corrosion-detection tests, including water analyses, and corrosion-rate coupons.
- Periodic metal-thickness surveys, including use of nondestructive instruments and actual metal-thickness measurements.
- Periodic visual inspections of equipment.

Here is a description of these methods, and a suggested general procedure for conducting an over-all corrosion-survey program in a compression-absorption-type natural-gasoline plant.

Author is with Pure Oil Co., Tulsa. Paper presented at annual meeting, Natural Gasoline Association of America, Fort Worth, April 11-13.

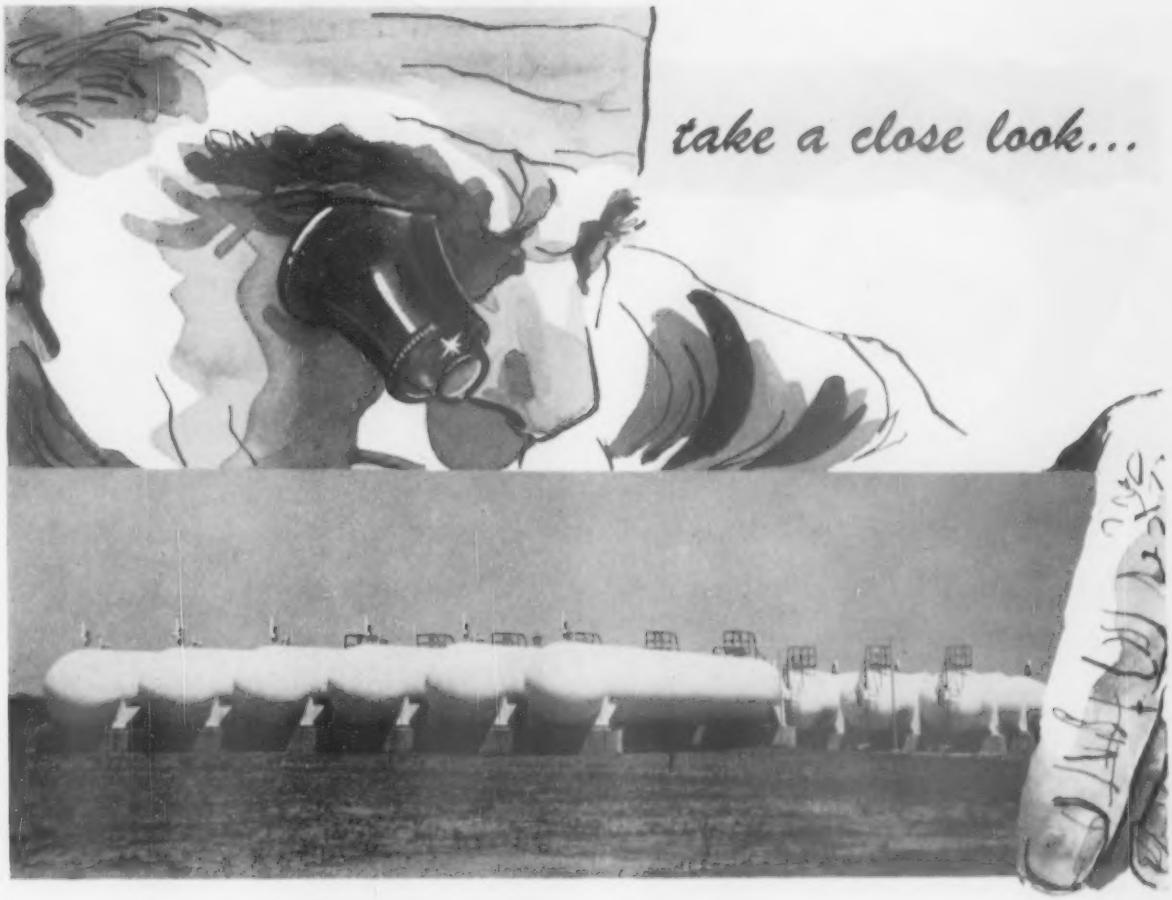
Locating corrosion . . . Corrosion-rate coupons and magnetic-particle crack indications are probably most useful in locating corrosion. Metal thickness determinations and visual inspections are useful in establishing degree of corrosion.

The corrosion-rate-coupon method of determining presence and degree of corrosion consists of placing a piece of metal, identical or similar to that of the equipment, into the fluid being handled. Coupons are sometimes inserted directly into the main fluid stream by means of a lubricator, or they are installed by a bypass or side stream. After exposure, coupons are sent to a laboratory where an evaluation is made to determine the loss of metal rate, and other observations are made for clues which might possibly reveal the cause or causes of corrosion. This method is of increased value in maintaining mitigation control once corrosion has been determined and located.

Water analyses . . . Water and/or steam condensate analyses have proved useful in ascertaining the presence of corrosion. Water samples taken from various equipment drains are analyzed to determine iron, copper, oxygen, and acid gas content. The pH of these waters should be checked and the volume of water drained from each source measured over a period of time. The evidence of corrosion and the degree of severity will usually be indicated by the result of these tests.

A good record of the analyses will often forewarn the engineer of the beginning of corrosion or serve as a good mitigation control. To a certain extent, this test method can be used to determine corrosion rates, but the exact location and degree of corrosion in most cases cannot be ascertained in this manner.

The presence of scale, coloring, or sludge in the water drained from process equipment or in plant products is possible evidence of corrosion somewhere in the plant. An analysis of the scale or sludge will usually indicate whether or not corrosion is present.



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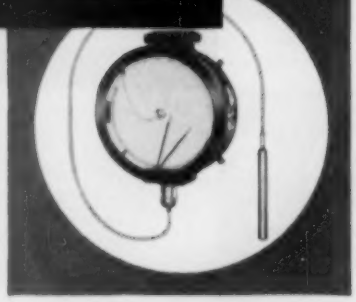

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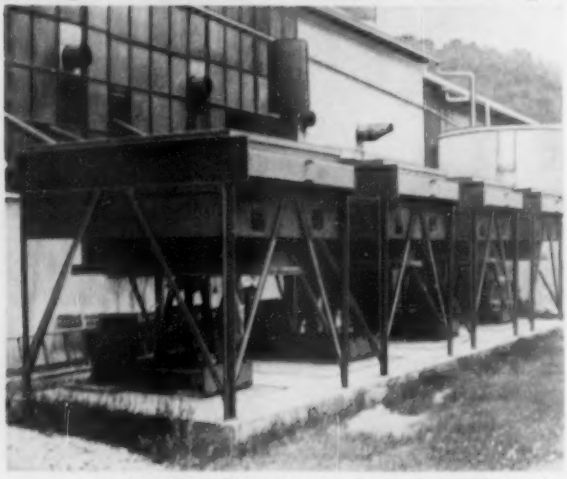

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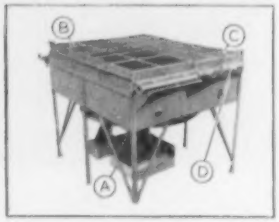

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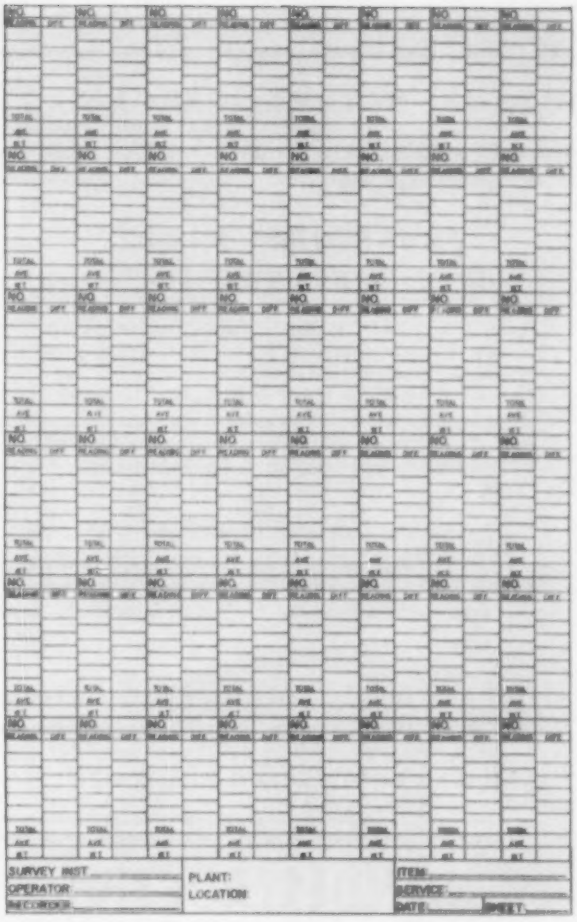
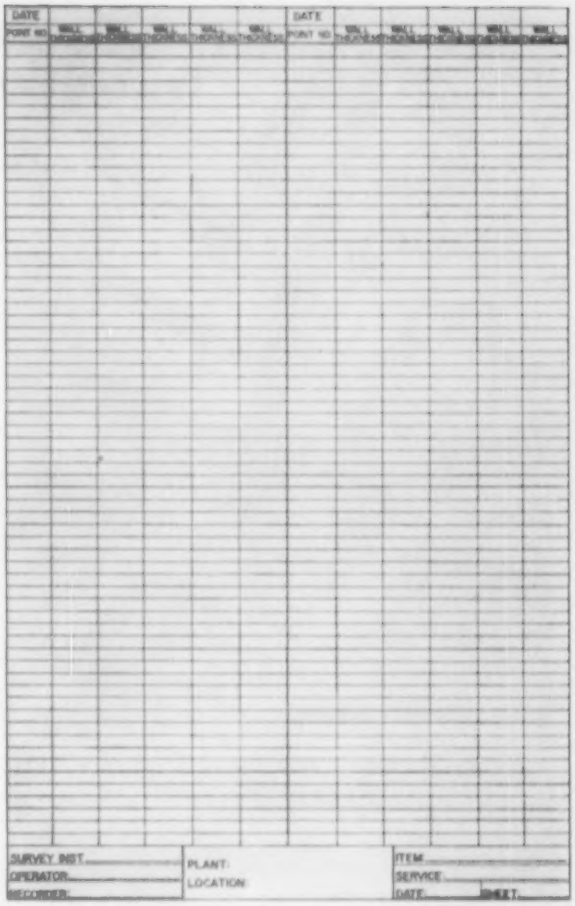


WORK SHEET for use with ultrasonic instrument. Fig. 3.



SUMMARY SHEET for reporting results of surveys. Fig. 4.

Field Processing

Here again the locations and concentrations are unknown.

The magnetic-particle crack indication method is normally confined to the determination of stress corrosion cracks in process equipment. Dry-powder magnetic particles are applied to a dry, clean exterior surface. The interior surface must also be dry and free from thick deposits of iron sulfide or other scale. This method of inspection is effective since it is nondestructive and rapid, and it clearly and accurately defines cracks.

Metal-thickness determination is merely the measurement of the metal by actual measurement methods (micrometer, hook scale, etc.) or by use of nondestructive instruments. To measure material thickness it is usually necessary to drill holes and determine the thickness with a special micrometer or hook scale.

Nondestructive instruments . . . Of the nondestructive instruments available for determining metal thicknesses, there are, generally speaking, two basic types in use. One type is an ultrasonic instrument, while the other is a radioactive-type instrument. Both operate on the reflective principle, i.e., thicknesses are determined by the reflected ultrasonic vibrations or the intensity of back-scattered radiation.

There are, however, variations in design of radioactive-type instruments, and in some instances direct radiation is used to determine thicknesses. A nondestructive instrument survey when used in conjunction with a visual inspection survey, is probably the best procedure today for determining the condition of vessels and tanks.

For examples of two popularly used nondestructive test instruments, refer to Figs. 1 and 2. Fig. 1 is an ultrasonic type instrument, and Fig. 2 is a radioactive instrument. This ultrasonic instrument is a portable, battery-powered instrument which is carried by means of a harness attached to the operator.

This is necessary because the standard coaxial cable connecting the detecting unit and the transducer is approximately 4 ft. long. The operator usually holds the transducer in place and reads the instrument while a second man records the location and instrument readings obtained by the instrument operator.

Basically, ultrasonic instruments are composed of a transducer (quartz crystal) and a detecting unit, electrically connected. The quartz crystal, having the power of converting electrical energy to ultrasonic vibrations and mechanical energy to electrical, alternately acts as a transmitter and receiver. Signals are reflected from the nearest opposite surface and made audible or visible by suitable circuits. The instrument in Fig. 1 is designed for audible use; however, the meter in the upper left-hand corner is sometimes used for visual check purposes.

Radioactive type . . . This instrument, shown in Fig. 2, utilizes 110-volt a.c. power supply and to a certain extent is not portable. This instrument, however, is normally used with a 100-ft. cable connecting the control box and the head. The operator remains at the control box at some convenient location to

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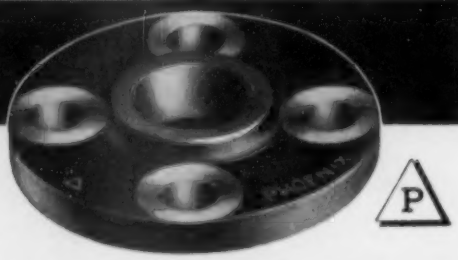

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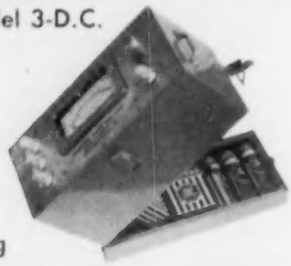

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operate, read and record readings, while an assistant carries the portable head from point to point on equipment. If more portability is desired, a battery-powered instrument of this type has been recently developed.

This instrument is composed of two basic components; namely, the head and the control box. Also, heads of two different designs are available for checking both piping and plate thicknesses. The standard head, used to check large pipe, vessels, and flat plates, contains a radium source, detector, a shield between the two, and a preamplifier. It is connected by a cable to the control box which contains the measuring circuit and power supply.

Penetrating gamma rays emerge from a radioactive source and penetrate into the material being checked. Some of the rays pass through the material and emerge on the opposite side (these rays serve no useful purpose), but some of the radiation is scattered in all directions by the electrons of the atoms which make up the material and emerge on the same side of the source. It is this back-scattered radiation that is utilized in measuring wall thicknesses.

The tangential head, which is used to check small piping, employs the same method of operation as the standard head except direct radiation rather than back-scattered radiation is used to determine thicknesses.

Since different designs of heads and transducers are available for both instruments for checking different types of equipment, the special application of each should be studied and the various types of equipment needed should be on hand commencing a survey.

Visual inspections, particularly of the internal section of tanks and vessels and the external section of all plant facilities, provide a very good means of determining the presence and location of corrosion. The results, however, greatly depend on the thoroughness of the inspection and the experience of the inspector. Internal visual inspections have the disadvantage of requiring shutdown, cleaning of equipment, and are probably the most dangerous from a safety standpoint.

Economic Considerations

Economics are the very essence of a corrosion survey. It is for this reason that careful planning and advance preparation is necessary. Of course, safety is always of prime importance, and it is to be understood that in any case, safety always takes precedence. As a matter of fact, the safe way is always the most economical way.

In practically all instances, plants of this industry are in services where down time is unheard of except for rare emergencies. A survey must be arranged so as to minimize down time and subsequently reduce the loss of all products including liquid products and residue gas.

What is the most economical to the plant will usually prove the most economical to other functions and operations in the field, but consideration must still be given to the inconveniences caused by plant shutdown to the purchaser of residue gas and liquid products, and to the lease operator and seller of gas to the plant.

Economic study must be given in making the decision to contract the survey to an engineering test service or to conduct the survey using your own personnel. The decision depends on individual circumstances. However, your own men are familiar with the equipment, know the location of various equipment, the process flow and the general habits of each individual piece of equipment.

These men will naturally show more interest in the objective to be accomplished, and the results will be of greater value to them due to their direct contact with the survey. The survey of individual units may possibly be con-

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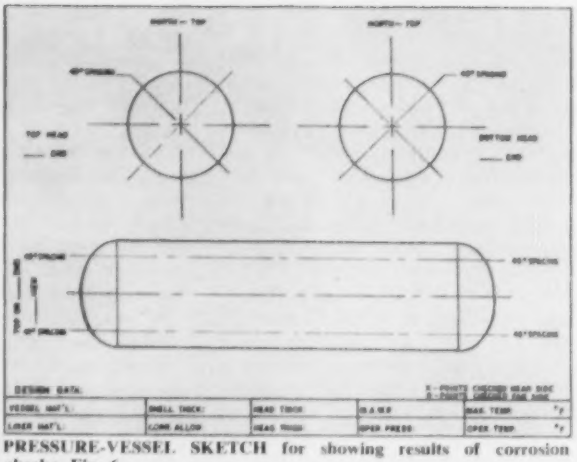
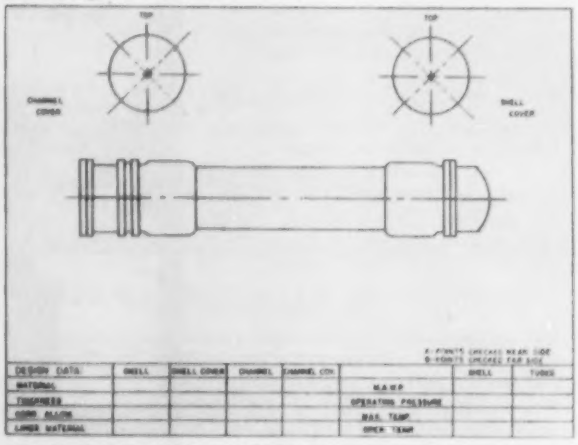
BASIC FORMS and headings are combined to make a form which provides space for sketches. Fig. 5.



PRESSURE-VESSEL SKETCH for showing results of corrosion checks. Fig. 6.



HEAT-EXCHANGER DIAGRAM for reporting results of corrosion checks. Sketches are important part of program. Fig. 7.

Field Processing

ducted at different periods of time which would also prove quite costly using outside services.

On the other hand, there are certain definite advantages in using engineering test services. It is sometimes advantageous to obtain such service for small plants and short surveys. In instances when purchase of a nondestructive test instrument cannot be justified or trained technical personnel are not available to conduct the survey, both instruments and experienced operators are available from various service companies on a fee basis.

Such service may also be beneficial in obtaining first-hand knowledge of the results obtainable from various test instruments before selecting a particular instrument for purchase.

General Procedure

The sequence to follow in the use of the different methods of corrosion detection is important from a cost standpoint. Generally, the first action taken consists of water analyses (pH and iron content), scale analyses, and general external observations, the results of which will indicate to some extent the presence of corrosion. The general location of corrosion can usually be tied down to units or sections by these observations.

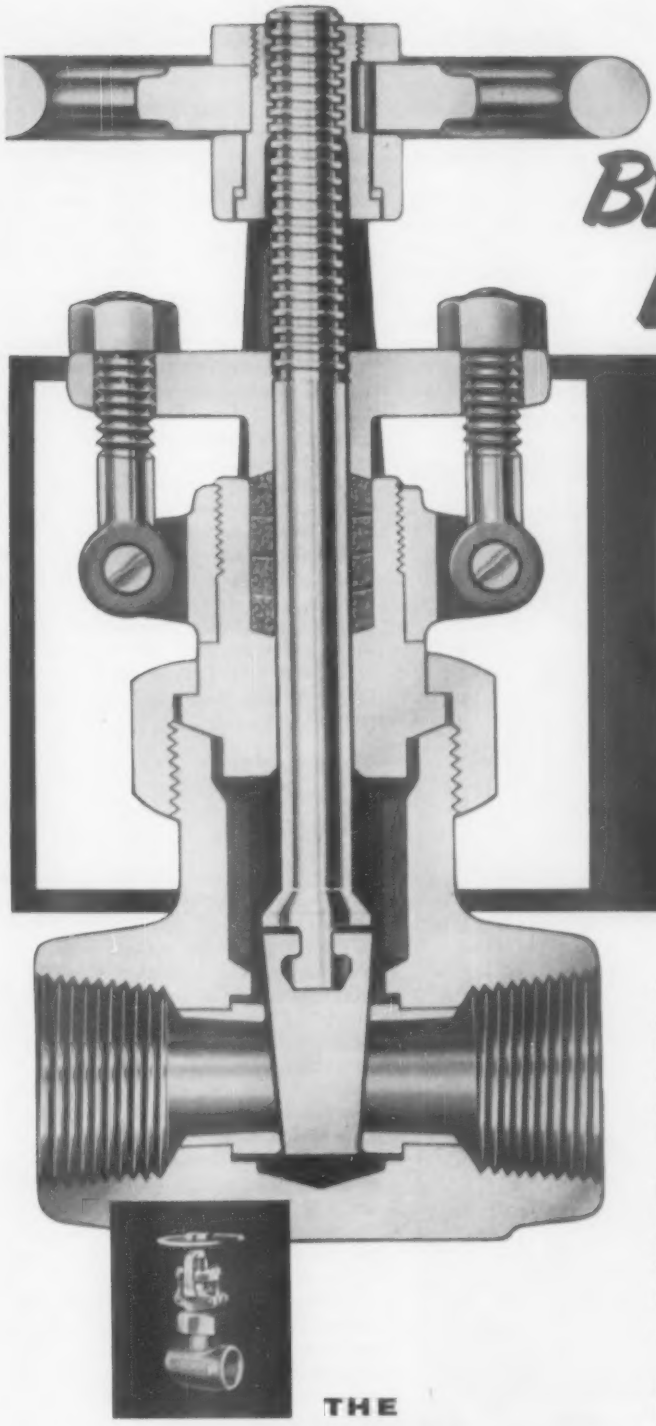
Based on results obtained from the initial action, corrosion-coupon tests would next be in order to determine the severity of corrosion in the particular sections analyzed. The results of these tests and observations should indicate the general condition of equipment.

The next step would be to check the thickness of piping and vessels by the use of a nondestructive instrument or instruments. It is often advantageous to utilize both an ultrasonic and a gamma-ray-type instrument to expedite the survey. Location of check points should be determined prior to testing. One of the greatest time-consuming factors in this phase of the corrosion survey is the recording of the location of the points checked with nondestructive test instruments. When possible, it is well to locate check points on piping in relation to pipe supports.

For example, it might be desirable to check the piping at every other pipe support (approximately every 50 ft.) at points 1 ft. north or east (depending on the piping layout) of the pipe support. It is not a good practice to check the piping at only one point; at least four points, top, bottom, and sides, are recommended. Again, recording time can be saved if piping points are given location numbers and a suffix used to indicate point positions.

It is preferable to always locate position No. 1 at the top, No. 2 at the north or east, and in so doing, the direction of rotation is automatically established. For example, it would only be necessary to refer to a particular location for recording purposes as 12-1, 12-2, 12-3, 12-4. With the aid of sketches it would be a simple matter to locate the exact point a particular reading was made, No. 12 in this instance.

Pressure vessels . . . Location of points checked on pressure vessels can be accomplished in a manner similar to the



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method outlined for piping. Vessels which are not accessible for internal visual inspection should be checked more thoroughly. Bubble towers in this category should be checked at eight points equispaced circumferentially at every tray section on the liquid-level line and at 1 to 2-in. increment spacings in the vapor and liquid sections between trays.

Other vessels which do not have access openings for visual inspections and liquid surge sections in bubble towers should be checked at eight points equispaced circumferentially at 5-ft. spacings. In addition, circumferential checks should be made at all liquid-level lines including interface levels, and at some convenient location circumferentially, the vessel should be checked at 1 to 2-in. spacings at least 1 ft. above and below liquid-level lines.

Vessels equipped with manways, both in the shell and through trays, need not be checked as thoroughly. It is recommended to check these vessels at four points equispaced circumferentially at liquid-level lines above the two top and bottom trays, all feed trays, and one tray above and below the feed trays. Other vessels and liquid surge sections of bubble towers should be checked at four points equispaced circumferentially on 10-ft. spacings and all liquid level lines.

Nozzles on all vessels should be checked at four equispaced circumferential locations approximately halfway between the vessel and the flange. Points of possible corrosion determined by previous tests, or during the survey in progress, should be checked more thoroughly.

Pressure vessel heads should also be thoroughly checked. Each head should be checked at a minimum of eight points for vessels that cannot be visually inspected inside, but four points on each head should be sufficient for vessels which are accessible for internal inspections.

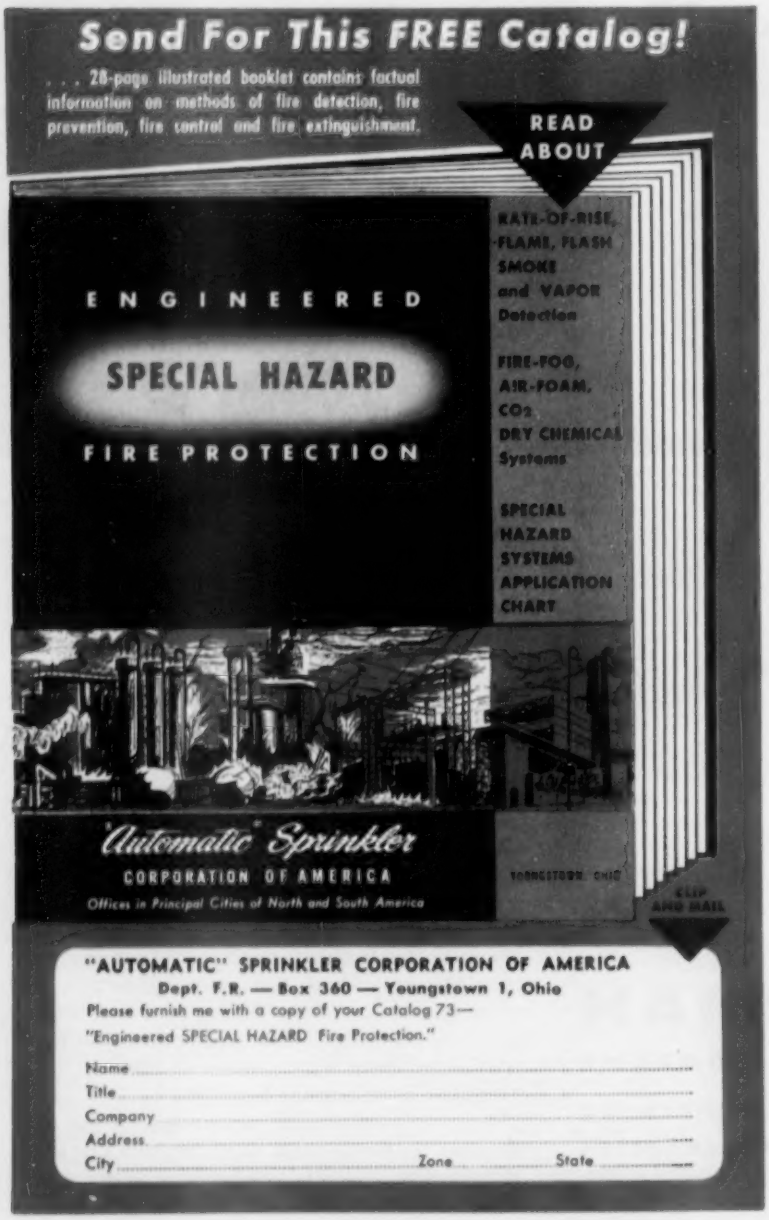
Heat-exchange equipment, boilers, heaters, pumps and drivers and other miscellaneous equipment should also be included in the survey. Since such equipment is usually installed in multiple, inspections are generally conducted during normal maintenance shutdowns. The extent of the survey of this equipment will, to a great extent, depend on the plant and the circumstances.

Sketches and forms . . . For record purposes it is imperative that sketches be made to locate the points checked on vessels and piping and other equipment. To assist in this task, the use of forms is highly recommended. For examples of forms which have proven satisfactory for this purpose, refer to Figs. 3 through 7. Figs. 3 and 4 are basic forms which are used as second sheets. Figs. 5, 6, and 7 are examples of various headings which can be combined with basic forms, Figs. 3 and 4, to make separate data sheets for use as sheet No. 1.

Fig. 5 shows how the basic forms and headings are combined to make a form which provides space for sketches. The particular form shown in Fig. 3 is designed primarily as a work sheet for use with an ultrasonic type instrument, while Fig. 4 is designed for use as a summary sheet in reporting the results of current and subsequent surveys.

Spaces have been provided for results of five different surveys so that metal thicknesses determined during subsequent surveys can be tabulated. This facilitates an easy comparison of the results of several surveys. For ease of reproduction, summary sheets are printed on transparent paper and Diezo copies are supplied with reports. Somewhat more work is required initially in the preparation of such a form, but future benefits and savings justify the effort.

Special forms are not used in recording readings taken with the gamma-ray-type instrument, but the same summary forms are applicable and are used.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Field Processing

Scaffolding . . . After locating check points on drawings, suitable scaffolds should be erected where necessary, and the equipment surfaces prepared for inspection (such as removal of insulation, wire brushing, etc.). Considerable forethought should be devoted in planning the sequence in which equipment is to be checked. If it is necessary to erect scaffolding around numerous vessels, the schedule should be arranged to allow for dismantling from one vessel and erection around another.

Easily accessible equipment can be checked during scaffold dismantling and erection periods to avoid loss of time. Depending on individual surveys, it may be possible to drill piping and vessels for micrometer measurement checks or conduct internal vessel inspections before scaffolding is removed. It may, on the other hand, prove to be more economical to hold this phase of the survey for a more opportune shutdown time, especially if a complete plant survey is in progress.

After completion of the nondestructive instrument survey, indicated thin sections should be verified by micrometer measurement or some similar method. Of course, equipment must be taken out of service for this phase of inspection, and if time permits, the visual inspection is definitely recommended.

Consensus is that there is not a substitute known for a good visual inspection. True, visual inspection should be supplemented with a thickness check method, but one look is still invaluable to the engineer in preparing his conclusions and making recommendations for future use of equipment.

Actually, all of the recommended preliminary work has been to establish the general condition of the plant with one purpose in mind—to save down time. For this reason it is necessary to accurately and comprehensively analyze and correlate the result of all preliminary tests conducted to pinpoint the particular sections or vessels which must be checked the most thoroughly during the micrometer measurement and visual inspection surveys. With this information at hand, the planning of the shutdown can be undertaken.

Safety points . . . It is considered most important to point out again the visual inspection is the most dangerous, and the survey should always conform to good safety practices in all respects. Suitable ladders, platforms, and scaffolding should be provided for work above ground level. All vessels to be internally inspected should be cleaned and purged of all explosive mixtures

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Extreme caution should be exercised when hydrogen sulfide is present, and iron sulfide should be disposed of to prevent a fire hazard. The unit to be inspected should be blocked off from the other units in such a manner as to prevent leakage from one to the other (locking of valves or the use of blind plates is sometimes necessary).

All personnel should be advised of the work to be performed. Wash water and contaminates should be disposed of immediately.

It will probably be advantageous to perform the micrometer check and visual inspection survey of the plant in sections to avoid a complete shutdown. In case of multiple installations in several different units, inspections can be performed easily without loss of operating time to the plant. When complete standby facilities are not provided, the plant in most instances can be economically operated at reduced throughput to permit inspection of equipment.

Arrangements can usually be made to isolate the shutdown to sections such as: absorption-distillation facilities, fractionation section, gas-treating section, and compression station. Sometimes product specifications can be changed for short periods to avoid complete loss of products or reduce loss of operating time.

Typical Survey

A brief example of a corrosion survey of a typical oil-absorption-type gasoline plant operating with sweetening and dehydration facilities might be as follows. For purposes of corrosion survey, the equipment in this particular plant was divided into the following general classifications: (1) boilers, (2) direct-fired heaters, (3) deaerating heater, (4) cooling tower, (5) compressors, (6) electrical system, (7) shell-and-tube heat-transfer equipment, (8) air coolers, (9) pressure vessels, (10) pumps and drivers, (11) storage, and (12) piping and loading facilities.

This plant was equipped with three boilers, and one boiler could be removed from the line without affecting plant operations. The exposed water walls and tubes were checked by nondestructive instruments at three different locations to ascertain wall thicknesses. Water wall header hand plates were removed for internal inspection. Visual inspection of the fire box, refractory, draft duct piping, draft fan, emergency equipment, mud drums, steam drums and continuous blowdown equipment was also made to determine

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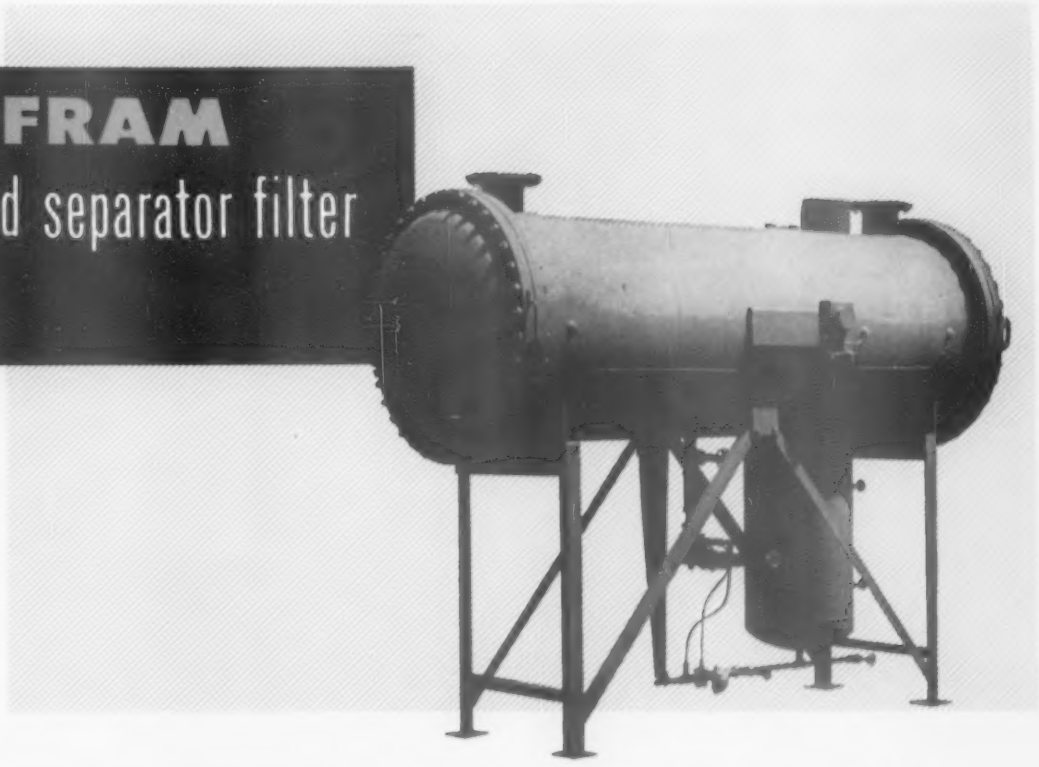

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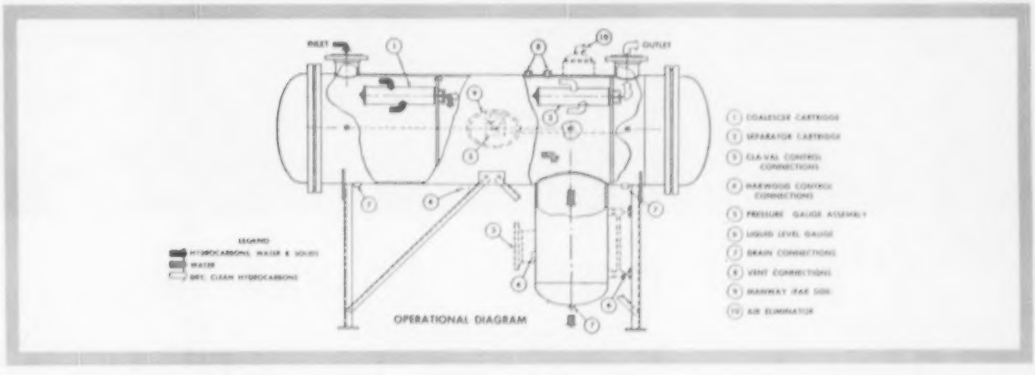

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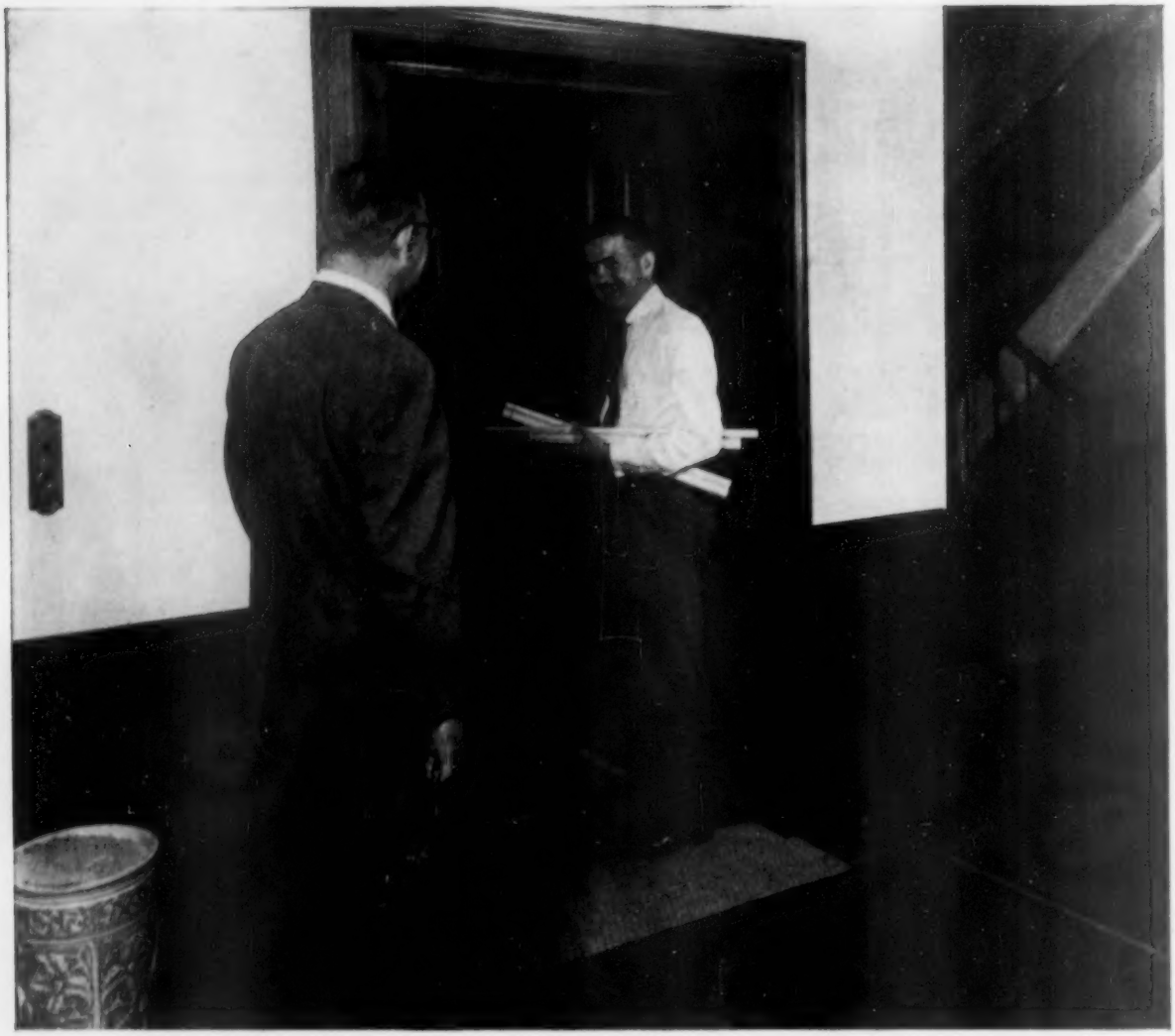

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Field Processing

if any foreign deposits, corrosion, or cracks existed.

Two direct-fired heaters each capable of handling three-fourths of the plant capacity were in service, which enabled oil circulation of the plant to be reduced without undue loss of plant product recovery, and each heater to be inspected separately. Scaffolding was erected inside the heater and each tube checked by both types of nondestructive test instruments to determine wall thickness.

To check the possibility of coking, a visual check was made by passing a light through several of the tubes. Also, a hammer check was made on each individual tube. Further inspection included visual checking of refractory, stainless steel cone, hangers, stacks, burners, thermowells, and emergency equipment.

The deaerating heater unit was checked by a nondestructive instrument survey before the shutdown. The metal thickness was checked at each medium-phase change at four points around the vessel (two points on top and two on the bottom) and at other points of likely corrosion. Following the instrument survey, visual internal inspection was made of all accessible areas. For a limited time it was possible to bypass this unit without seriously affecting plant operations.

Exchangers . . . The inspection of shell-and-tube heat-transfer equipment, including reboilers, heat exchangers, and coolers, consisted of conducting nondestructive instrument survey and subsequent removal of equipment from service for internal visual inspection. The typical pattern for checking this equipment was to check four points (top, bottom, and sides) at each end and one point was checked in the middle at the bottom. Since there were standby facilities, units could be bypassed and completely disassembled for internal inspection.

To obtain a preliminary evaluation of pressure vessels, water drawoff at selected locations was checked for pH iron content before conducting a nondestructive instrument survey. A complete or semicomplete internal visual inspection followed. Monoethanol amine and diethylene glycol towers were given a complete internal visual inspection which consisted of the removal of all tower manway openings and inspection of all accessible areas. Other vessels were visually inspected only at manways.

Plant storage equipment condition was first evaluated by a nondestructive instrument check. Tanks were checked

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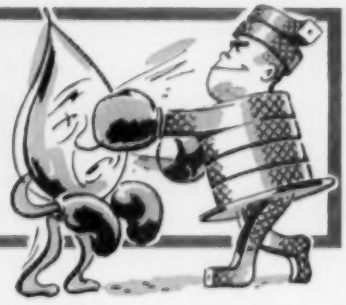

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Field Processing

by instruments at four locations on each end and at quadrants around the tank at 10-ft. intervals. One of each group of product storage tanks was internally inspected.

The aboveground plant piping system was checked for metal loss using a nondestructive instrument at four points (top, bottom, and both sides) at 50-ft. intervals and at each turn. Both types of instruments were used on piping where practical. In instances where corrosion was suspected or determined as being present by prior tests, piping was drilled and tapped for micrometer measurements.

The condition survey of equipment such as cooling towers, compressors, electrical, air-cooled coolers, pumps, and drivers, was conducted along with a preventive-maintenance program. For example, pumps and drivers—the impellers, blades, nozzles, bearings, seals, pump or turbine housing, etc.—were inspected to determine general operational condition and to detect corrosion or erosion which might be present.

Acknowledgment

Presentation of this paper was made possible through the cooperation and contribution of numerous supervisors, engineers, chemists, and other employes of Pure Oil Co. The author wishes to express thanks and appreciation to these associates for their assistance.

BOOK

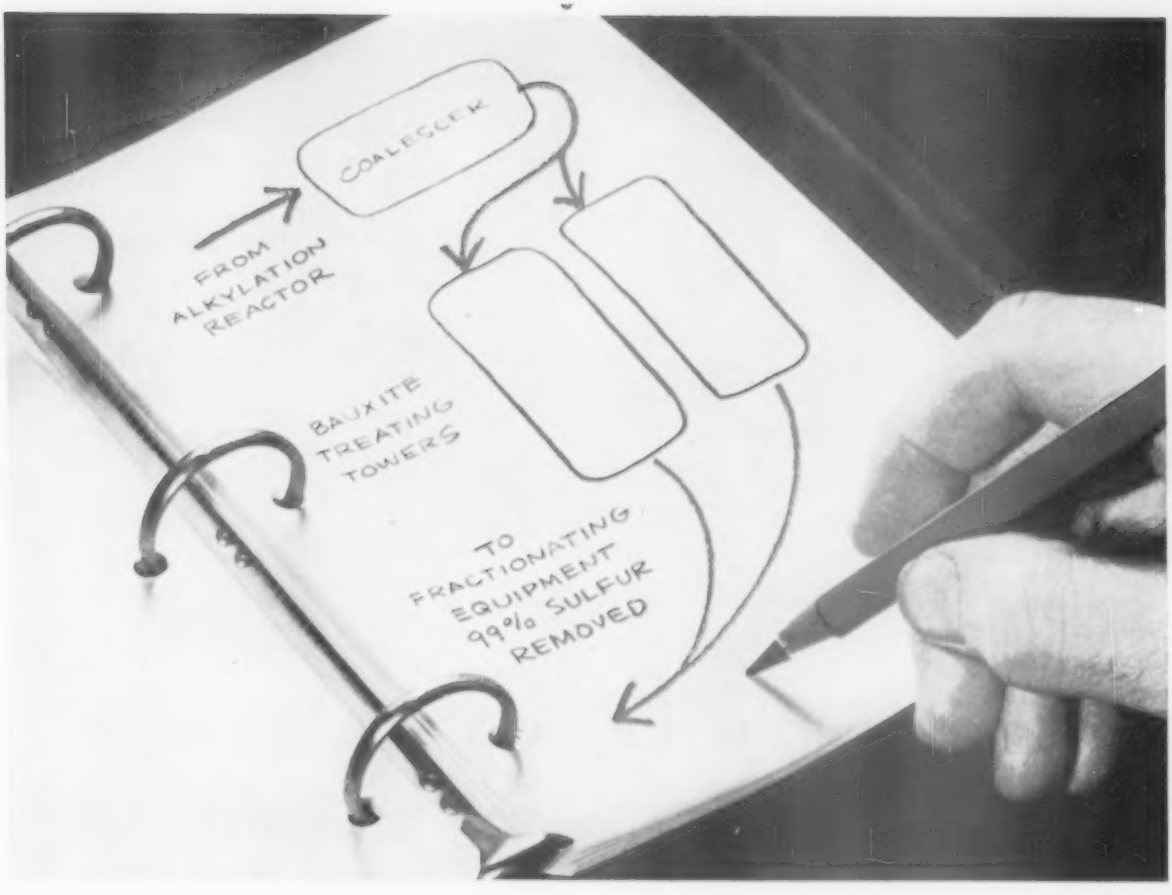
CATALYSIS—Volumes 1, 2, and 3. Edited by Paul H. Emmett. Published by Reinhold Publishing Corp., 430 Park Avenue, New York 22. Volume 1, 394 pp., $10. Volume 2, 473 pp., $12. Volume 3, 504 pp., $12.50.

This series of books provides research chemists and others working in the field of catalysis with a well-integrated, soundly conceived treatise on the physical chemistry of catalysis and catalytic processing. It presents comprehensive discussions not only on established ideas and interpretations, but also the wide range of newer concepts now associated with the field of catalysis.

Volumes 1 and 2 cover the general approaches and tools used to obtain a basic understanding of both homogeneous and heterogeneous catalysis.

Volume 1 is devoted to fundamental theory, catalyst supporters, carriers, and methods of preparation. Volume 2 concludes the discussion of fundamental theory and classifies catalysts according to current ideas of solid state physics.

Volume 3 summarizes existing knowledge on the subjects of hydrogenation and dehydrogenation. Among the many important topics covered are hydrogen-deuterium exchange and such commercial processes as the synthesis of ammonia and methanol, the dehydrogenation of butane and butene to form butadiene, and the hydrogenation of olefinic hydrocarbons.



The Answer to Alkylation Maintenance

New bauxite process removes 99% sulfur from alkylation reactor effluent

Reduced corrosion, decreased fouling in alkylate fractionating units, and savings in tetraethyl lead result from a new bauxite process of treating reactor effluent which has been developed jointly by D-X Sunray Oil Company and The M. W. Kellogg Company.

Sixteen months' experience with this process shows that it removes 98 to 99% of acid and both acidic and neutral esters from the alkylation reactor effluent. This compares with 65% sulfur removal obtained in conventional caustic wash systems.

The new bauxite process uses a coalescer to provide the equivalent of added settling time. This horizontal vessel separates suspended microscopic drops of acid and sulfur hydrocarbons. The effluent then percolates down through medium mesh bauxite in one of the two treating towers, where acid and esters are preferentially adsorbed. The towers are alternately regenerated.

This new process not only eliminates maintenance problems caused by residual acid, but also saves tetraethyl lead, due to the improved lead susceptibility of the sulfur-free alkylate. Additional advantages include lower acid consumption and elimination of inhibitors.

The process is licensed by The M. W. Kellogg Company. Design data are available for five standard sizes, ranging from 5,000 to 25,000 bpsd. of reactor effluent.

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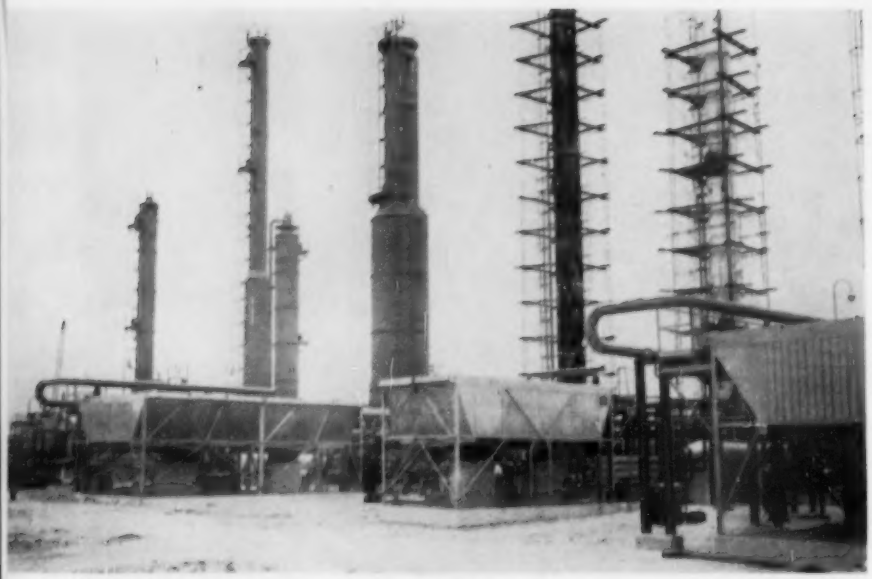


THESE SIX TOWERS at the new Redfish Bay plant are (left to right): absorber; rich-oil stabilizer; absorber; still; depropanizer; and debutanizer. In the foreground are Arrow Transaire coolers.

By Ben Lovell
Sunray Mid-Continent Oil Corp., Corpus Christi, Tex.

and

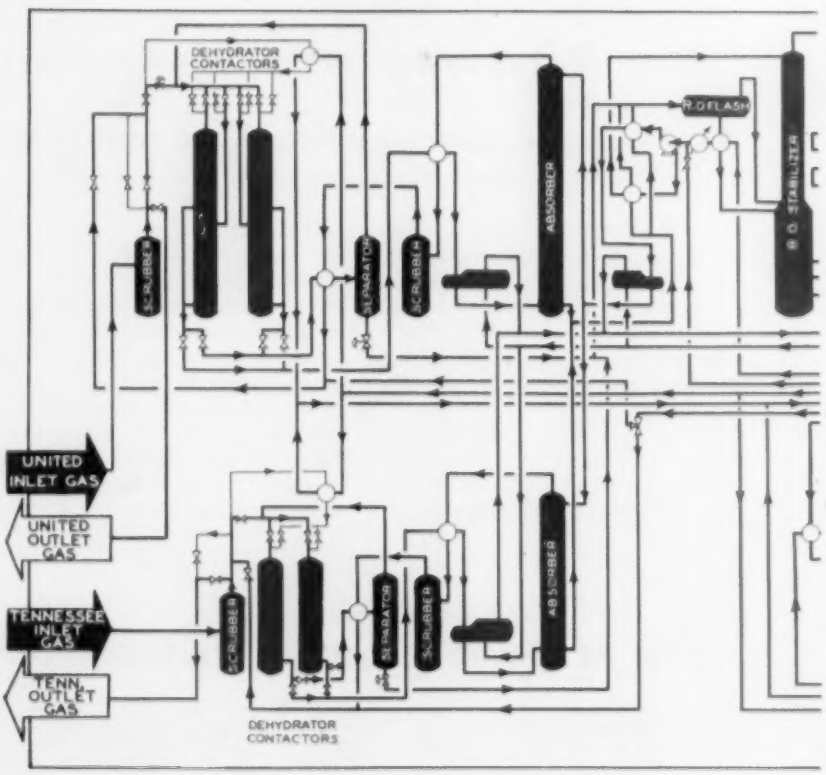
Larry Resen
District Editor

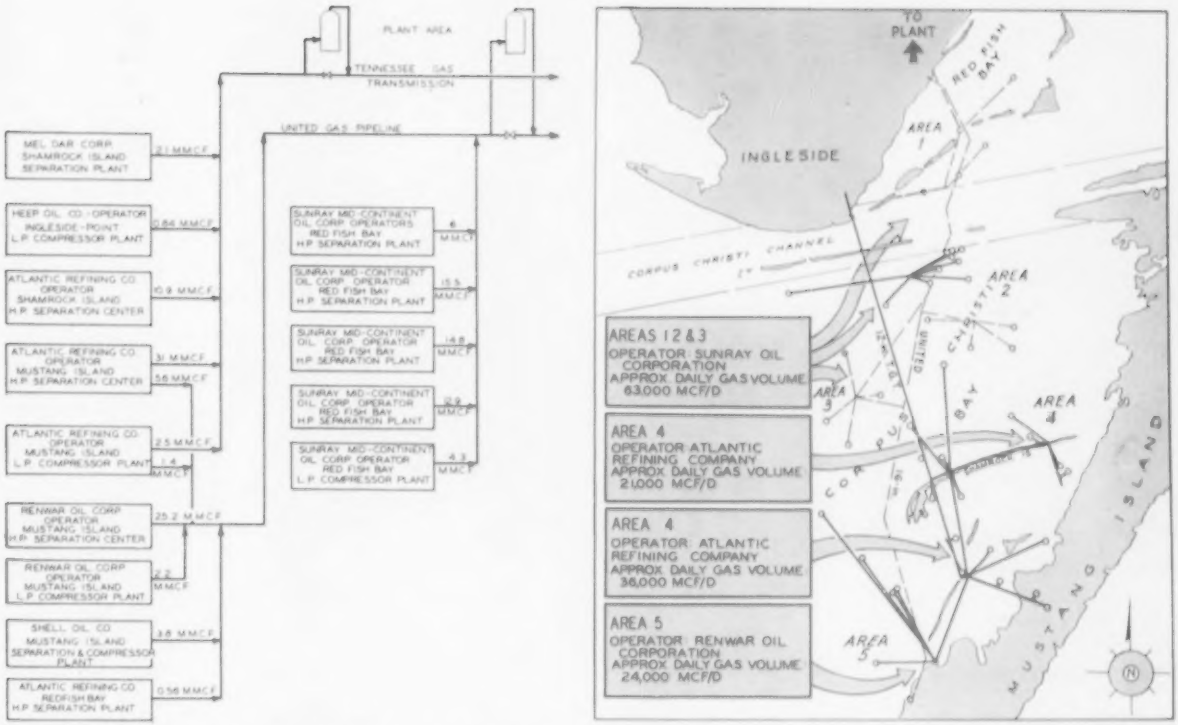
Offshore Gathering System Features New Redfish Bay Gasoline Plant

- Dual gas handling facilities to process a minimum of 84,000 M.c.f. of gas per day and a peak of 220,000 M.c.f. per day.
- Process units to recover products from 140,000 M.c.f. of gas per day.
- Extremely dry process gas—less than 1 gal. per M.c.f. of liquids extracted.
- High capacity refrigeration: 1,800 hp. to chill gas and absorption oil to minus 10° F.
- Eight-stage centrifugal lean oil pumps with low-pressure side stream takeoff.
- Absence of steam and high degree of electrification.
- A high degree of instrumentation and many protective devices, resulting in a reduction in required manpower. . .

. . . These are some of the features of the Redfish Bay processing plant due on stream next month.

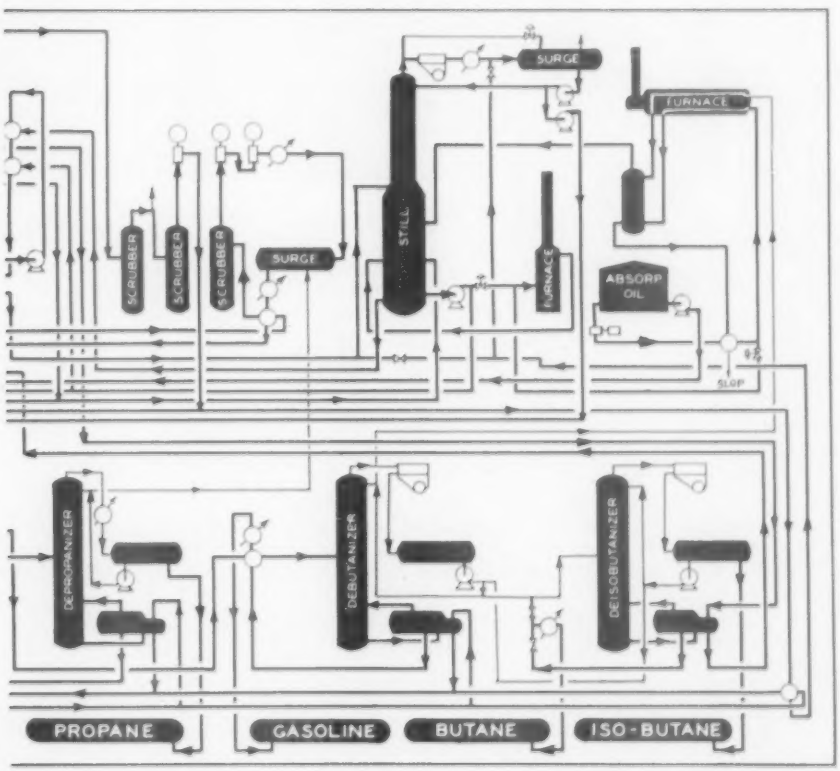
The plant, located about 15 miles east of Corpus Christi, Tex., near Ingleside, is operated by Sunray Mid-Continent Oil Co. which has a 56 per cent interest in it. Other owners are Renwar Oil Corp., 16 per cent; Shell Oil Co., 9 per cent; Sinclair Oil Corp., 9 per cent; Tide Water Associated Oil Co., 6 per




PLANT AREA
TENNESSEE GAS TRANSMISSION
UNITED GAS PIPELINE
MEL DAR CORP. SHAMROCK ISLAND SEPARATION PLANT
21 MMCF
HEEP OIL CO. - OPERATOR INGLESIDE-POINT L.P. COMPRESSOR PLANT
0.84 MMCF
ATLANTIC REFINING CO. OPERATOR SHAMROCK ISLAND H.P. SEPARATION CENTER
10.9 MMCF
ATLANTIC REFINING CO. OPERATOR MUSTANG ISLAND H.P. SEPARATION CENTER
31 MMCF
56 MMCF
ATLANTIC REFINING CO. OPERATOR MUSTANG ISLAND L.P. COMPRESSOR PLANT
2.5 MMCF
1.4 MMCF
RENWAR OIL CORP. OPERATOR MUSTANG ISLAND H.P. SEPARATION CENTER
25.2 MMCF
RENWAR OIL CORP. OPERATOR MUSTANG ISLAND L.P. COMPRESSOR PLANT
2.2 MMCF
SHELL OIL CO. MUSTANG ISLAND SEPARATION & COMPRESSOR PLANT
3.8 MMCF
ATLANTIC REFINING CO. REDFISH BAY H.P. SEPARATION PLANT
0.56 MMCF
SUNRAY MID-CONTINENT OIL CORP. OPERATORS RED FISH BAY H.P. SEPARATION PLANT
6 MMCF
SUNRAY MID-CONTINENT OIL CORP. OPERATOR RED FISH BAY H.P. SEPARATION PLANT
15.5 MMCF
SUNRAY MID-CONTINENT OIL CORP. OPERATOR RED FISH BAY H.P. SEPARATION PLANT
14.8 MMCF
SUNRAY MID-CONTINENT OIL CORP. OPERATOR RED FISH BAY H.P. SEPARATION PLANT
9.2 MMCF
SUNRAY MID-CONTINENT OIL CORP. OPERATOR RED FISH BAY L.P. COMPRESSOR PLANT
4.3 MMCF
TO PLANT
RED FISH BAY
INGLESIDE
AREA 1
CORPUS CHRISTI CHANNEL
AREA 2
CHRISTI
AREA 3
AREA 4
CORPUS CHRISTI BAY
MUSTANG ISLAND
AREA 5
AREAS 1 2 & 3
OPERATOR: SUNRAY OIL CORPORATION
APPROX. DAILY GAS VOLUME 63,000 MCF/D
AREA 4
OPERATOR: ATLANTIC REFINING COMPANY
APPROX. DAILY GAS VOLUME 21,000 MCF/D
AREA 4
OPERATOR: ATLANTIC REFINING COMPANY
APPROX. DAILY GAS VOLUME 36,000 MCF/D
AREA 5
OPERATOR: RENWAR OIL CORPORATION
APPROX. DAILY GAS VOLUME 24,000 MCF/D
N

HOW gas flow to Redfish Bay plant is divided by companies (Fig. 1, left) and by geographical areas. Fig. 2.

New installations operated by Sunray due on stream in May. Designed to handle up to 220,000 M.c.f. of gas daily from the Redfish Bay - Mustang Island fields.



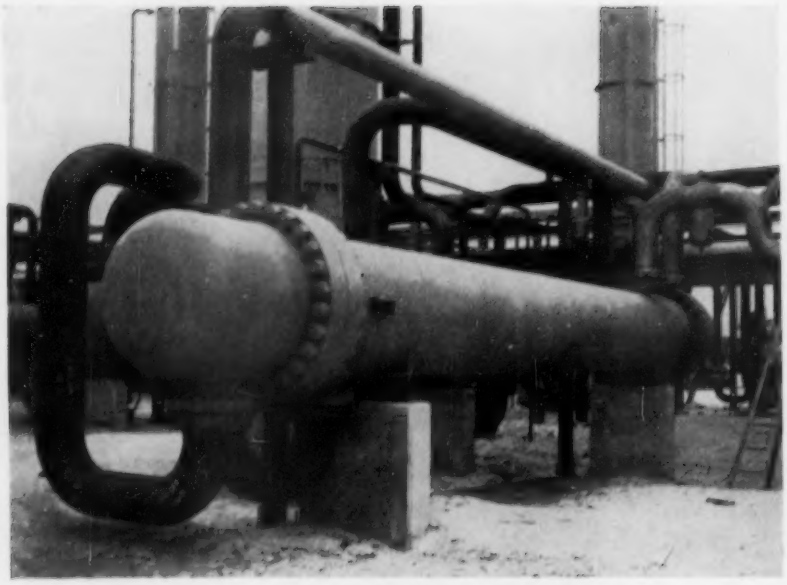
SIMPLIFIED flow sheet of the new plant, which was designed by Dresser Engineering Co. for Sunray Mid-Continent Oil Corp., Tulsa.

cent, and Arkansas Fuel Oil Corp., 4 per cent.

The Redfish Bay installations were designed, engineered, and constructed by Dresser Engineering Co., Tulsa.

Incoming gas is received at the plant in two streams from Tennessee Gas Transmission Co. and United Gas Pipe Line Co. These gas streams are gathered from oil and gas wells in nearby Redfish Bay and Mustang Island fields in Corpus Christi Bay. This gas is exceptionally lean (Tables 1 and 2) having a liquid content of 0.858 g.p.m. This condition results from the extensive use of low-temperature separation and compression units in the fields.

Field breakdown . . . Gas from approximately 250 oil and 50 gas wells in the two fields is gathered into the two pipelines and processed at the plant. Redfish Bay-Mustang Island fields have been joined by development drilling and each has numerous producing zones. However, they are connected only by the gas sand known as Common Zone 10. Total gas reserves from the two



THIS main United Gas exchanger has 1,100 psi. on both tube and shell sides, and is rated at 7 million B.t.u. per hour.

Field Processing

fields have been calculated to be in excess of 1 trillion cubic feet, most of which is in Zone 10.

Gas production has been divided into five areas. One of the producing companies in each area operates the jointly owned gas separation, dehydration, compression, and distillate handling facilities (Figs. 1 and 2). These areas are operated as follows:

Area—	Gas wells	Separation plants	Approximate gas volume, M.M.c.f.d.	Installed casing-head comp. hp.	Operator
I, II, and III	16	4	58	2,200	Sunray
IV	19	2	51	1,760	Atlantic
V	8	1	30	880	Renwar
Shamrock Is.	2	1	4	200	Mel Dar
Ingleside point			2	250	Heep
State Tr. 466 No. 5	1	1	3	175	Shell
	46	9	148	5,465	

Most of these gas wells are relatively high-pressure, high-volume wells, with flowing tubing pressures generally ranging slightly above 2,000 psi. The separation plants are principally glycol-type low-temperature separation units, with accompanying distillate stabilizer plants. In addition to the nine separation plants, six low-pressure compressor plants in the fields pick up casing-head gas and low-pressure stabilizer gas from the separation plants, boost its pressure, and inject it into the pipelines to the plant.

Process . . . Gas is delivered to the plant by Tennessee Gas Transmission Co. and United Gas Pipe Line Co. in two separate lines. These gas streams are processed on a segregated basis through scrubbing, dehydration, and absorption steps, and residue gas is returned to the respective pipeline without commingling.

Sunray built a 20-in. double line to United's system, 1,000 ft. away, and a double 16-in. line to T.G.T.'s system, 6,500 ft. away, for handling the gas. Contractor on these jobs was Petroleum Construction Co., of Corpus Christi.

Gas-handling facilities for United's gas including piping, dehydration, and absorption are sized to handle 24,000 to 70,000 M.s.c.f.d. Thus, the plant is set up to handle wide fluctuations in process gas streams, depending on main pipeline requirements.

Scrubbing . . . The incoming gas streams flow through inlet gas scrubbers where free liquid is separated from the gas. The gas then passes through conventional solid-desiccant type dehydrators containing Florite as an adsorbent. The Tennessee Gas dehydrators are designed for 12-hour cycles with heating for the regeneration gas being supplied from the hot oil system and cooling by plant residue gas.

The United dehydrators are similar, except that the dehydrator towers are separated into two sections with a diaphragm dividing the sections. Half of the flowing gas is dehydrated in each section. Gas to each section is metered so the flow may be balanced. This type tower keeps the gas velocity within specifications and greatly decreases the diameter of the tower required. Investment in pipe, valves, fittings, and controls is increased considerably, but more than offset by the decreased chamber costs.

Gas from the dehydrators exchanges heat with gas from the absorbers to reduce the refrigeration load. At that, 1,800 hp. is installed in the propane refrigeration unit which operates on two-stage compression. The incoming precooled gas streams are chilled to minus 10° F. by the refrigeration propane vaporizers before entering the absorbers.

Under these conditions the plant is designed to operate with a low-molecular-weight lean oil—140 M.W., 0.75 S.G. Oil-circulation and cooling facilities are designed to recover a minimum of 80 per cent propane and 95 per cent of the butanes in the processing of 140,000 M.s.c.f.d. of lean gas. Design recoveries were based on incoming gas ranging in temperature from 50°-90° F. and from 800 to 1,000 psig. pressure. Cooling facilities were based on 95° F. dry-bulb temperature and 78.5° F. wet-bulb temperature.

Absorption and distillation . . . Absorption is accomplished in conventional 30-tray absorbers. Lean oil to the ab-

TABLE 1

Oil circulation and cooling facilities are designed on basis of incoming gas with following analysis at 140,000 M.s.c.f.d.:

	Mole per cent	G.p.m.
Carbon dioxide	.37	
Methane	93.30	
Ethane	3.54	
Propane	1.47	.403
Isobutane	.54	.176
n-Butane	.36	.113
Isopentane	.13	.047
n-Pentane	.10	.036
Hexanes	.10	.041
Heptanes plus	.09	.042
	100.00	.858

TABLE 2

Liquid-handling facilities are designed to handle product from incoming gas with following analysis at 140,000 M.s.c.f.d.:

	Mole per cent
Carbon dioxide	.37
Methane	92.61
Ethane	3.57
Propane	1.64
Isobutane	.66
n-Butane	.46
Isopentane	.21
n-Pentane	.15
Hexanes	.18
Heptanes plus	.15
	100.00

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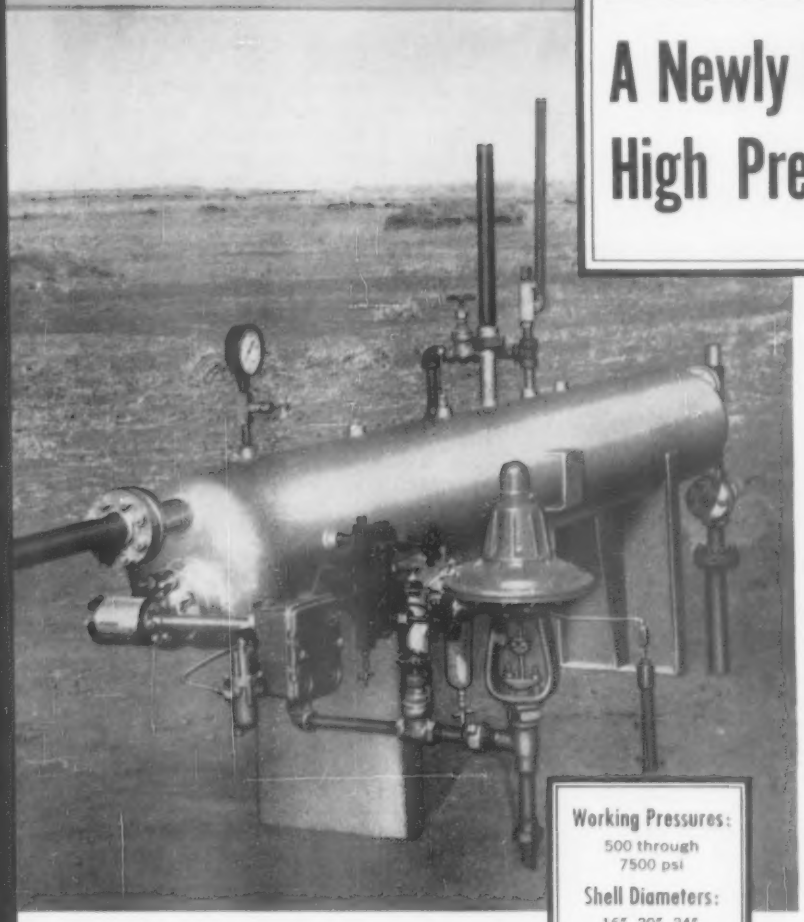

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1. Separation Efficiency. Model DC utilizes a highly efficient inlet deflector as a primary separating element and combines a turbulent-free separation section with an efficient mist extractor section to remove liquid particles 10 microns in size and larger.

2. High Capacity. Dual gas and liquid chambers in a single barrel provide a large surge capacity.

3. Maximum Release of Solution Gas. Maximum liquid retention and large liquid surface area permit maximum release of solution gas.

4. Cold Weather Operation. The internal design of the Model DC gives excellent cold weather operating characteristics.

5. Sensitive Controls. Model DC utilizes the excellent BS&B Type 889 Liquid Level Controller with the BS&B Type 1450 Pilot, which has throttling and snap action range and gravity adjustments. The displacement element is located in the turbulent-free liquid chamber to effect constant interface level.

6. Convenient Hook-Up. All of the controls are located at one end and on the same side of the separator for convenience and neat appearance.

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Field Processing

sorbers is first chilled to minus 10° F. as is the gas. Rich oil from the absorbers is commingled and enters the rich-oil flash tank from where it is charged to the rich-oil stabilizer.

The main lean-oil pumps are specially fabricated eight-stage centrifugal units discharging at 1,000 psig. A side stream is taken off a side nozzle after the second stage and charged to the top of the rich-oil stabilizer at 225 psig., thereby eliminating a separate pump.

The stabilizer essentially deethanizes the rich oil, with heat supplied to the base of the tower by the lean oil from the still. Overhead vapors are used for plant fuel requirements with the excess being recompressed and combined with residue gas.

TABLE 3—CALCULATED PURE COMPONENT RECOVERIES

	Processing 140,000 M.s.c.f.d. lean inlet gas			Processing 140,000 M.s.c.f.d rich inlet gas		
	Mole/day	Gal./day	Calc. rec. per cent	Mole/day	Gal./day	Calc. rec. per cent
Ethane	138	330	.....	146	1,407	.....
Propane	4,453	46,356	82.00	5,010	52,154	82.70
Isobutane	1,994	24,686	99.95	2,437	30,170	99.95
n-Butane	1,330	15,880	100.00	1,699	20,286	100.00
Isopentane	480	6,643	100.00	776	10,740	100.00
n-Pentane	369	5,059	100.00	554	7,595	100.00
Hexanes	369	5,745	100.00	665	10,354	100.00
Heptanes plus	332	6,142	100.00	554	10,249	100.00
	9,465	111,841	.....	11,841	142,955	.....

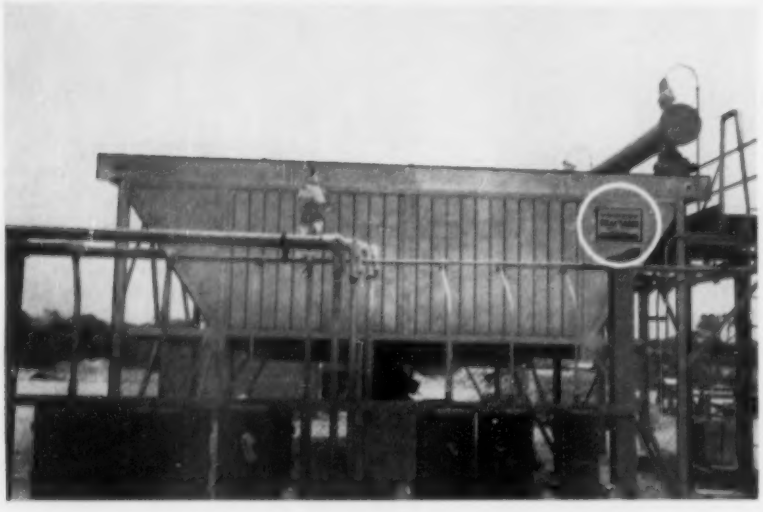
Rich oil from the stabilizer is fed directly to the still without any additional heating. The still bottom section is divided into two sections. A pump takes suction from one side and this oil stream divides with a portion going through the furnace and a portion being used for plant heating requirements. The temperature of the stream is maintained by a temperature instrument controlling the flow through the furnace. There are no steam facilities.

The temperature of the oil from the furnace is maintained by a conventional furnace-firing temperature controller. The portion of the oil used for plant heating is returned to the pump suction side of the still and heated oil is returned to the hot side of the still. Part of this hot oil leaves the still as kettle product and part recombines with the oil descending the tower and the oil returned from heating services. The base of the still is also used for the plant lean-oil surge.

An oil reclaimer reclaims 2½ per cent of the total oil circulation. Oil is charged to the reclaimer by the hot oil pump and is heated in a salt bath heater to the desired vaporization temperature. Facilities are included to charge butane to the oil stream to reduce temperature required for vaporization and a separate coil is included in the salt-bath heater for vaporizing butane for use as a stripping medium. The vaporized oil and butane flow back to the still base.

Extra capacity is included in the reclaimer to produce the required plant makeup lean oil from distillate stocks. The heavy end of the stock is removed in the reclaimer and the light end leaves the still in the overhead vapors to be recovered in the plant gasoline production.

Fractionation . . . Still overhead vapor is partially condensed in an air-fin cooler and then totally condensed by shell-



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and-tube condensers. Pressure is maintained by a hot gas bypass around these condensers. Raw gasoline from the still is charged to the depropanizer. This tower operates conventionally using shell-and-tube cooler for reflux condensing. Ninety-five per cent purity propane will be produced overhead of the 40-tray depropanizer and the bottoms fed to the debutanizer. This tower uses air-fin reflux condensing and gasoline debutanized to 26-lb. R.v.p. can be produced as the bottom product.

Mixed butanes from the debutanizer reflux accumulator are fed to the deisobutanizer. As can be seen in the plant stream analyses (Tables 1 and 2) a high proportion of isobutane is present in the gas. This is also reflected in Table 3 where pure-component recoveries are listed.

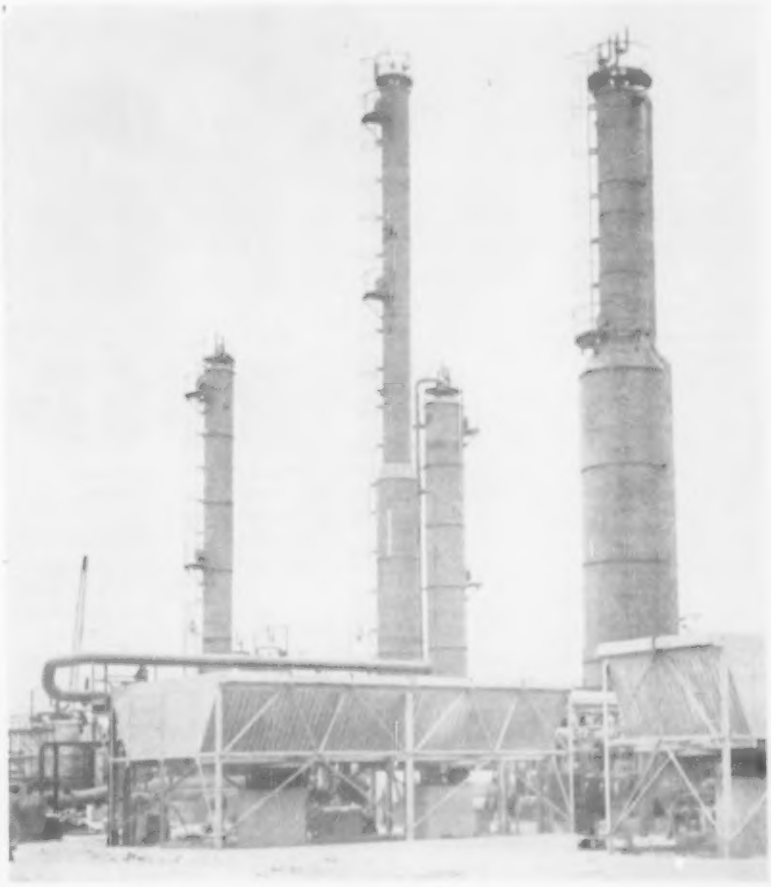
Isobutane recovery is higher than that of normal butane. As the field pressures decline and the low-temperature separators are taken out of service, inlet gas to the plant will be correspondingly enriched by these components now recovered in the field units.

The deisobutanizer uses air-fin reflux condensing and 95 per cent purity isobutane is produced as the overhead product. Bottoms product is 95 per cent purity normal butane.

Miscellaneous . . . Estimated plant recompressor and refrigeration horsepower required is 2,400 hp. which permits the use of two 1,320-hp. units with a 91 per cent load factor. This provides some flexibility for handling gas volumes in excess of the design rate of 140 M.M.c.f.d. Power drives for the plant are completely electric with the exception of five gas engines. These are used to drive the two compressors, two lean-oil pumps, and the fire water pump.

Side-flow-type cooling tower is installed with a 25-million-B.t.u. per hour capacity. This is open on one side to take advantage of the prevailing winds. The other three sides are enclosed in corrosionproof Transite. Additional cooling is provided by seven finned coolers with a combined capacity of 33 million B.t.u. per hour. Field construction on the plant was begun in early October.

Acknowledgments . . . Cooperation of the management of Sunray Mid-Continent Oil Co. in the release of this material and the cooperation and assistance of L. L. Buck, chief engineer, gas section; L. M. Ford, Gulf Coast district superintendent, gas section, and H. H. (Pat) Everett, Ingleside plant superintendent, are gratefully acknowledged.



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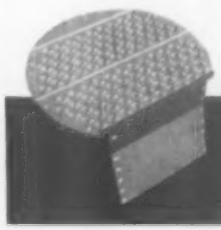

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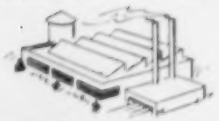

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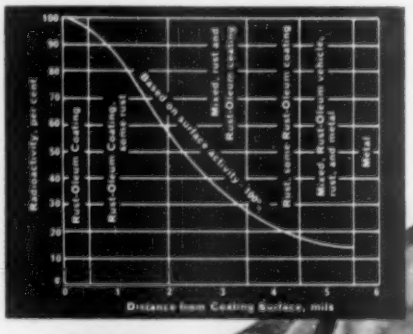
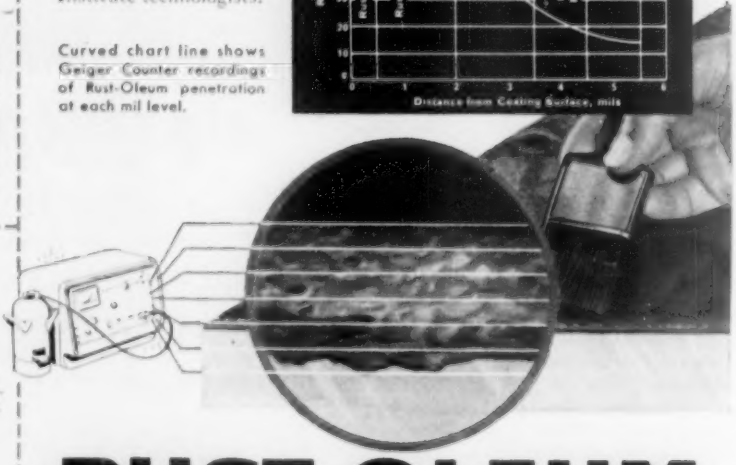


Curved chart line shows Geiger Counter recordings of Rust-Oleum penetration at each mil level.



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A.P.I. Committee Reports on . . .

JET-BIT DRILLING

. . . It has had a tremendous effect in cutting drilling costs in the last 3 years. And in the soft-rock country of the Gulf Coast, drilling rates are still improving as more attention is paid to the complete hydraulic system and bit weight.

JET-BIT drilling and drilling hydraulics have been under study by A.P.I. study committees over the past 3 years. Recently, committees of the Southern District of the A.P.I. Division of Production reported their findings. These committees studied drilling in the Texas Gulf Coast, Louisiana Gulf Coast, and the Arkansas-Louisiana-Texas area. Here are some of their conclusions:

- Upward annular mud velocities between 100 and 150 ft. per minute are usually safe.
- Minimum jet velocity for use of jet bits is about 190 to 200 ft. per second.
- Principal benefit of jet bits is in the drilling of softer formations and in these formations no optimum upper nozzle velocity has been established.
- Drilling rates are continuing to improve when drilling procedures include increases in both hydraulic horsepower and bit weight.

Tips for better results . . . Some of the pointers the committee collected for getting better jet-bit results are:

1. More benefit may result from increased jet velocities at lower rotary speeds than at high rotary speeds, not only in easy drilling but in medium-hard drilling.
2. A practical limitation on high jet velocities exists where erosive, sandy muds are used.
3. Plugging of small jets can be a problem. Strainers on pumps are important. Breaking circulation on the way to bottom helps in some cases.
4. Advantages of compounded small pumps over a single big pump are: Compounding can increase rate of penetration 30 to 45 per cent and drilling is not seriously hampered by stoppage of one pump; and a greater range of pressures and more days of operation can be covered without changing liners of the compounded pumps.
5. Compounding in series is better than parallel because in the latter case when one pump is down drilling efficiency with only "half circulation" is very low.
6. An efficient pulsation dampener must be between pumps and after the second pump used in compound. Also, separate drive is used.
7. Oversize drill collars have been successful with jet bits because of the emphasis on good circulation and big pumps which keeps the hole clean.

This article is based on material taken from "Report on Hydraulics of Rotary Drilling," a three-part report on practices in Texas Gulf Coast area, Louisiana Gulf Coast area, and the Ark.-La.-Tex. area by T. W. Keating, Stanolind Oil & Gas Co.; W. D. Clift, Humble Oil & Refining Co.; and John Cutrer, Reed Roller Bit Co. The report was presented at the 1956 spring meeting of the Southern District of the A.P.I. Division of Production, San Antonio.

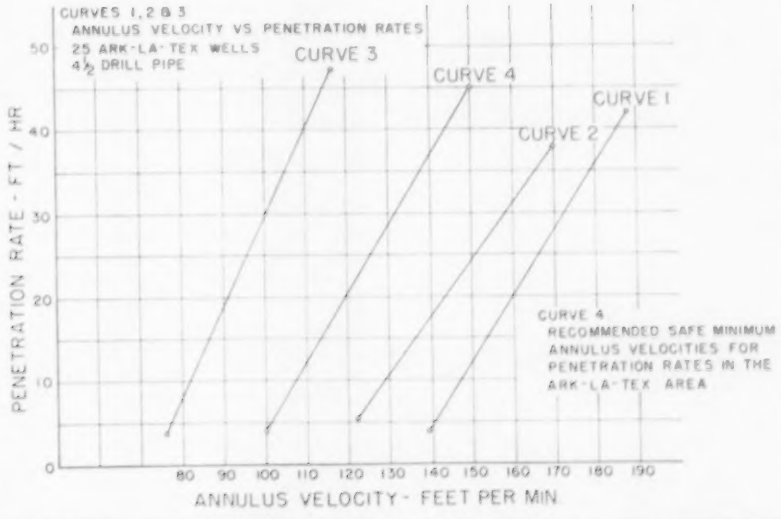
Annular Velocity

Investigations in both the Texas Gulf Coast and the tristate area reveal that many wells have been annular velocities of 100 to 150 ft. per minute and some have used less than 100 ft. per minute without adverse effects. In general, annular velocities are low in large holes and high in small holes. This is simply because the same pump equipment is used for the upper large-hole part of a well as for the small-hole lower part.

Table I shows data accumulated from the Texas Gulf Coast. Fig. 1 shows the range of velocities used in the Ark.-La.-Tex. area for different drilling rates. The committee recommends that the annular velocity corresponds to the drilling rate, i.e., 100 to 150 ft. per minute, is the recommended velocity range for drilling rates from 3 to 50 ft. per hour.

In cases where higher annular velocities are used, reduction of velocity may be of material benefit. For with a given pump horsepower, volume rate may be reduced to reduce drill-pipe pressure loss and make more pressure available at the bit for increasing jet velocity and bit horsepower.

Depends on shale . . . Simple calculations show very small volume of cuttings in the circulating mud for all but the fastest drilling with the largest bits, or with very low annular velocity. It appears, therefore, that any practical requirements for large upward annular velocities are more dependent upon uncertain sloughing shale fragment sizes and hole enlargements in shales than upon bit-cuttings removal.



LOWERING ANNULAR VELOCITY to between 100 and 150 ft. per minute has usually been safe in the Southern District. Curves 1, 2, and 3 represent data from 8½ to 9-in., 9⅞-in., and 12¼-in. holes. Fig. 1.

DRILLING

TABLE 1—UPWARD ANNULAR VELOCITIES—TEXAS GULF COAST

Well bore (in.)	Drill pipe o.d. (in.)	No. of wells	Circulation rate, g.p.m. Min.	Avg.	Max.	Annular velocity, ft./min. Min.	Avg.	Max.
15	4½	7	410	619	820	48	75	98
12¼	4½	10	250	490	712	47	93	138
9⅞	3½	1		295			86	
	4	2	326	383	440	98	116	133
	4½							
	5	2	390	485	580	124	160	197
8¾	4½	120	190	444	745	81	194	325
8⅝	3½	3	255	327	410	100	129	162
	4½	33	270	454	718	123	206	325
	5	11	345	534	880	172	266	440
7⅝ and 7⅞	3½	3	238	327	420	108	159	208
	4½	5	340	382	450	200	226	266
	5	3	222	407	520	147	271	318
6 and 6⅛	3½	7	130	226	340	126	220	330

Extremely low **calculated** annular velocities appear to be widely acceptable except in particular cases. Probable enlargements of hole diameter in various shales (hard as well as soft) still create a puzzle as to **actual** upward velocities therein and the necessary reduction of shale fragment sizes before they are carried up through such enlargements.

Jet Velocities

Minimum practical jet velocity depends more on bit life than on the inability of jet bits operated at low velocities to make hole faster than regular bits. For, in fact, a jet bit may make hole faster than a regular bit but still drill less hole. Data from the Ark.-La.-Tex. area bear this out.

Table 2 shows wells in the same field drilled with both regular bits and with jet bits using a velocity from 135 to 257 ft. per second. Wells A, B, C, and D were drilled by four different contractors. The others, wells E, F, G, H, and J were drilled by the same contractor. All used essentially the same bit program, drilling weights, mud program, rotary speed, drill pipe.

At a jet velocity of 165 ft. per second, rotating hours on well D were 18.6 per cent under the hours on well C, where regular bits were used. But well D used 11.1 per cent more bits than well C. Wells E and F, having jet velocities of 190 ft. per second, however, averaged one-half fewer bits than well C and required 21.6 per cent fewer rotating hours. Further reduction in bits and decrease in rotating time occurs at higher velocities. For best use of jet bits, a minimum nozzle velocity of 190 to 200 ft. per second is probably best.

Upper limits . . . Although the committees have received and studied many jet-bit drilling records there have been relatively few situations where constructive comparisons of upper jet velocity can be made. Usually not enough of the many variables affecting the drilling have been kept constant. As a result the several theories about the mechanism of the jet stream have not been fully confirmed. These are important to the study of the most efficient use of available hydraulic power.

For cleaning of the bottom of the hole the viscosity of the fluid of the jet stream is important. A thin cutting lies on the hole bottom in the region where the fluid molecules or microscopic particles are virtually stationary. The rate of velocity change from the hole bottom into the moving stream determines the sweeping or cleaning effect. Thus, with lower fluid viscosity and thus more abrupt velocity gradient, cuttings will move more readily.

Impact or horsepower? . . . Concerning the way the hydraulic energy is used at the bit, there are two theories. One is that the benefits are directly proportional to impact which in turn is proportional to volume rate of flow times velocity (QV).* The other is that the benefits are directly proportional to hydraulic horsepower which is proportional to volume rate of flow times velocity squared (QV^2).

Since both of these functions increase with either volume rate of flow and jet velocity, data obtained so far could support either theory, inasmuch as drilling rate increases with an increase in either function.

But the important application of the theories would be to determine where the optimum upper range of jet velocity or bit horsepower for a given rig might be.

Currently, bit horsepower is being increased both by increase in volume flow rate and bit velocity. But where pump horsepower is limited, the trend is to decrease volume rate and increase jet velocity by decreasing jet size. As a result horsepower is increased. If drilling rate is proportional to bit horsepower, it will go up. But if it is proportional to impact, it may not change since the jet velocity increase would be compensated for by the volume rate decrease.

Best use of pump . . . As a comparison of how drilling rate might increase depending on which mechanism is in effect, the following example is shown. With 375 hydraulic horsepower at the pump and 7,000 ft. of 4½-in. drill pipe, choose (1) a given liner size to deliver 530 g.p.m. at full rating; or (2) reduce speed to deliver only 450 g.p.m. so as to reduce drill-pipe friction and permit more of the available pressure for velocity at the jets (also decrease jet size); or (3) change liners to give same 450 g.p.m. but with more

TABLE 2—DRILLING COMPARISON, MALAKOFF FIELD, HENDERSON COUNTY, TEXAS

Hole size: 8¾-9-in. Average interval: 0-7,500 ft.

Well—	A	B	C	D	E	F	G	H	J
Number bits	2J 19R	22J	18R	20J	18J	17J	17J	16J	15J
Rotating hours	561	529	532	433	421	413	380	344	325
Average feet per bit	321	310	382	346	377	400	400	423	446
Average bit life, hours	26.7	24.0	29.6	21.7	23.4	24.3	22.4	21.5	21.6
Average penetration rate, ft. per hour	12.0	12.8	12.9	15.9	16.1	16.2	17.9	19.6	20.6
Average circulation rate, g.p.m.	355	310	350	375	350	350	370	400	360
Average Nozzle velocity, ft. per second	152	135	105	165	190	190	200	223	257
Average h.hp. expended at bit	30	29	29	51	67	67	83	100	123
Average pump h.hp.	127	108	97	163	162	162	180	244	244
Ratio bit h.hp. to pump h.hp.	.237	.268	.299	.312	.413	.413	.455	.410	.505
Orifice area in jets, in.²	1.1 0.746	0.746	1.1	0.746	0.589	0.589	0.589	0.589	0.450

Wells E and F drilled with same rig with 18-in. steam pump with 7¼-in. liners.
Wells G, H, and J drilled with same rig with 20-in. steam pump with 7¼-in. liners.
H.hp.: Hydraulic horsepower. R: Regular bits. J: Jet bits.

more

* Eckel, J. R., and Nolley, J. P., "An Analysis of Hydraulic Factors Affecting Rate of Penetration of Drag-Type Rotary Bits," A.P.I. Drilling and Production Practice, 9 (1949).

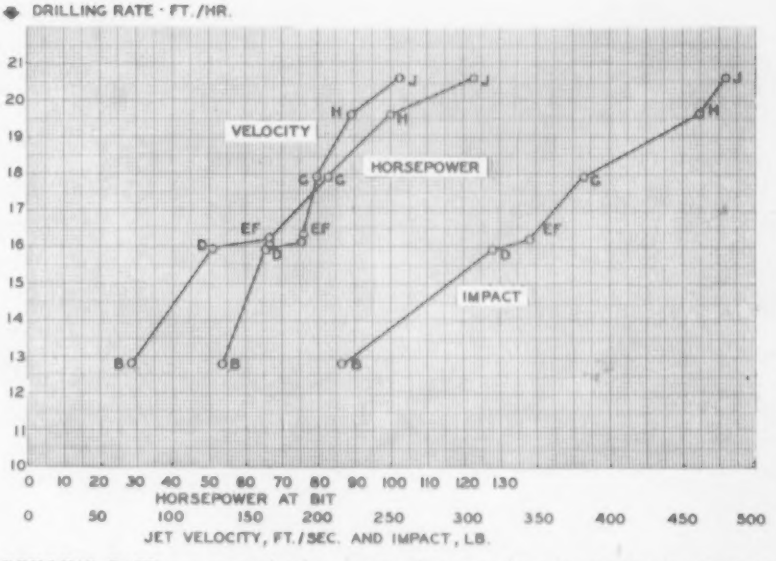
total pressure and thus more pressure and velocity at the jets. The effect would be as follows:

	(a)	(b)	(c)
Liner size, in.	6¾	6¾	6¼
Rated psi.	1,225		1,435
G.p.m.	530	450	450
Psi. available to jets	410	635	845
Jet hydraulic horsepower	220	275	315
Relative impact (QV)	1	1.06	1.21
Relative jet horsepower (QV^2)	1	1.31	1.75

Thus, if drilling rate is proportional to bit horsepower considerable increases can be made by changing the operation of the pump to give the best hydraulics. But if impact controls, the range of operation of the pump will have much less effect on drilling rate.

What data show . . . Tables 2 and 3 show drilling data from the Ark.-La.-Tex. area and Table 4 shows jet-bit drilling data for South Louisiana. For the wells in Malakoff field, Table 2, some interesting conclusions about mechanism may be made. For the higher jet velocities, wells E and F had the same rig with an 18-in. pump and 7¼-in. liners, and wells G, H, and J were all drilled by the same rig with a 20-in. pump having 7¼-in. liners.

Fig. 2 shows drilling rate plotted as a function of bit horsepower, jet velocity, and the impact function. Drilling rate shows a tendency to level off at upper values of horsepower and jet velocity, in this case 123 hp. and 257 ft. per second. But drilling rate increases practically linearly with impact and shows no sign of leveling off.



DRILLING RATE was proportional to impact (flow rate times jet velocity) in this Texas field (data from Table 2, 10-lb. per gal. mud assumed). Other data show linear relation to horsepower. Fig. 2.

For the rig that drilled holes G, H, and J the maximum practical velocity was being rapidly approached. On well H, the full capacity of the 20-in. steam pump was used with three ½-in. nozzles and a velocity of 223 ft. per second. The nozzle velocity was increased to 257 ft. per second on well J by decreasing nozzle size to ⅞-in. Horsepower increase was large, but as flow rate was reduced, the impact increase and drilling rate increase were small.

Question in other areas . . . The drilling data in Tables 3 and 4 fail to confirm the linear function between drilling rate and impact. Drilling rate from Woodlawn field, Texas, Table 3, appears to be a linear function of bit horsepower. Drilling rates in the South Louisiana wells, Table 4, corrected to common bit weights and rotary speeds, are erratic when plotted against either horsepower or impact. Fig. 3, which summarizes the data of Table 4, shows in general that jet-bit drilling rate increases with increase in bit horsepower and bit weight.

When the over-all drilling time curves for the four Louisiana wells are compared (Fig. 4), the remarkable result of using more hydraulic horsepower at the bit may be seen. These wells were all drilled in the same field over a period of 3 years. Drilling time to approximately 17,000 ft. has been reduced by more than 50 per cent since the drilling of well No. 1. It is of interest to note that the data on these wells

TABLE 3—WOODLAWN FIELD, MARION AND HARRISON COUNTIES, TEXAS

Average interval: 0-6,600 ft.

Wells—	A	B	C	D
Hole size, in.	8¾	9	9	9
Number bits	20.0	16.6	19.0	14.3
Rotating hours	510	472	461	405
Average feet per bit	330	396	347	460
Average bit life, hours	24.0	28.6	22.7	31.6
Average penetration rate, ft. per hour	12.9	14.0	14.3	16.3
Average circulation rate, g.p.m.	245	352	358	382
Average nozzle velocity, ft. per second	187	191	197	211
Average h.hp. expended at bit	64	68	71	86
Average pump h.hp.	169	174	161	194
Ratio bit h.hp. to pump h.hp.	0.378	0.391	0.441	0.443

Note: Wells A and B drilled with same rig and wells C and D drilled with same rig.

TABLE 4—FIELD-WELL DRILLING COMPARISON—SOUTH LOUISIANA

			Drilling fluid properties (all alk-tan oil emuls.)				Drill collars		Max. drift
Well	Hole size (in.)	Depth interval (ft.)	Weight (lb./gal.)	Visc. (sec.)	W.L. (cc.)	Drill pipe size (in.)	No.	Size (in.)	angle (deg.)
1	12¼	3,060 to 13,053	10.4	45	8.0	5	5	7¾	3
	8⅝	13,053 to 16,822	10.3	45	4.5	4 & 5	5	6½	3¾
2	12¼	3,550 to 14,525	9.9	43	7.6	5	5	7¾	2½
	8⅝	14,525 to 17,637	10.4	49	5.8	4 & 5	6	5⅞	2¼
3	12¼	3,050 to 14,557	10.0	45	9.0	5	8	7¾	1½
	8⅝	14,557 to 17,617	9.8	47	11.7	5	11	6½	5
4	12¼	3,030 to 12,020	9.8	45	12.5	5	11	7¾	2¼
	8⅝	12,020 to 16,906	9.9	41	9.1	4 & 5	14	6½	4¾

		Drilling rate	Rotary speed	Max. bit	Circ. press.	Hydraulic horsepower	
Well	Bits used	(ft./hr.)	(r.p.m.)	wt. (lb.)	(psi.)	Total	At bit
1	30	18.7	100	20,000	1,700	*505	160
	49	5.2	85	20,000	1,800	†325	150
2	36	24.2	150	20,000	2,500	*1,020	480
	43	5.7	110	12,000	2,500	†576	†134
3	37	22.6	100	20,000	2,500	*1,015	540
	38	7.7	90	15,000	2,500	†525	†225
4	16	38.4	110	30,000	2,800	*905	711
	32	12.1	90	20,000	2,800	†711	†218

*At 11,500 ft. †At 16,500 ft.

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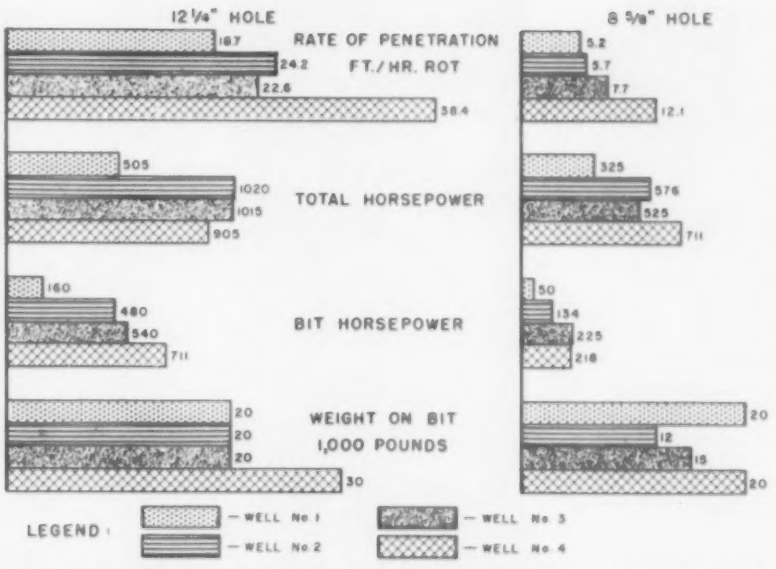
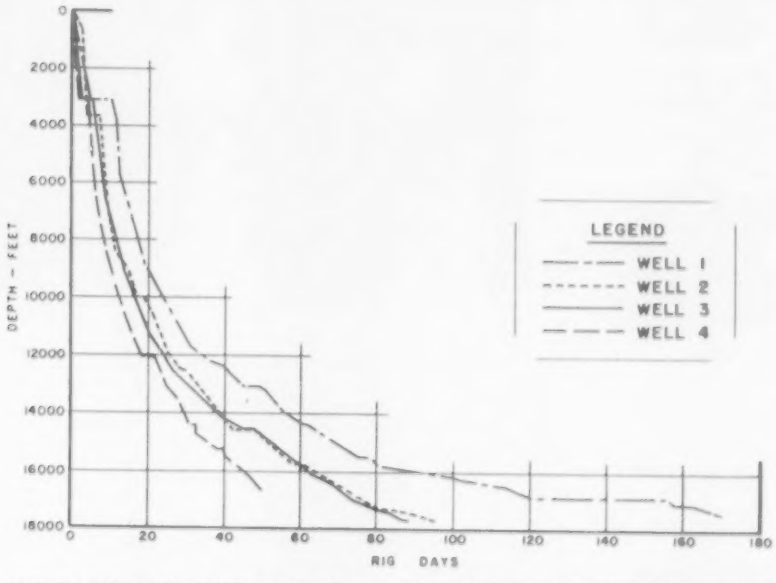


MORE HORSEPOWER AND WEIGHT will increase drilling rates in soft formations of the Gulf Coast. Economic limit has not been reached. Data from Table 4. Fig. 3.



CUT IN DRILLING TIME of over 50 per cent resulted from increasing horsepower and weight shown above in Fig. 3. These four wells drilled in a period of 3 years. Fig. 4.

indicate nozzle velocities of over 500 ft. per second for the 12¼-in. holes and over 300 ft. per second for the 8⅝-in. holes. In current drilling operations, still higher hydraulic horsepower and greater bit weights are being used economically.

Data from the Texas Gulf Coast for Red Fish Bay field show an S-curve relation between drilling rate and hydraulic horsepower at the bit. That is, at low values of bit horsepower, little improvement in rate of penetration accompanies an increase in horsepower. In the middle ranges of horsepower, drilling rate increases linearly with horsepower. And at high bit horsepower, only small increase in drilling rate occurs with increase in horsepower. For 8¾-in. bits, the middle horsepower range appears to be from 100 to 200 hp. for drilling rates from 10 to 30 ft. per hour and from 200 to 400 hp. for drilling rates between 30 and 80 ft. per hour.

S-curve explanation . . . An explanation of this peculiar effect is: (1) at low hydraulic power, there is not much bottom cleaning being accomplished by the jets anyway. Therefore, there is not much difference between the little benefit of one low jet velocity and the little benefit of another slightly higher jet velocity; (2) at certain intermediate jet velocities and volume rates, however, there begins to be some cleaning of bottom between the successive bit-tooth impacts, and this removal of crushed, but adhering fragments, is improved with increased hydraulic power application. Thus notable increases of penetration rate are accomplished with moderate increases of jet action; (3) however, at some higher hydraulic values, nearly all the possible cleaning is being done and no more benefit can accrue from further hydraulic power of the jets.

This explanation would indicate why higher velocities are more effective in softer formations or when bit weight is increased. If under maximum jet cleaning conditions the bit should go into softer formations or bit weight were increased, more formation would be broken by each bit tooth. Thus there would be more cleaning to be done and drilling rates would increase even more if jet velocity were increased.

What's resulting . . . Since the A.P.I. committees began their work, many changes have occurred in drilling. Larger pumps are being used and higher pressures are being tried to get more power to the bit. But operators are now also studying the hydraulic efficiency of the drill string and pump drives to see how to get maximum power to the bit.

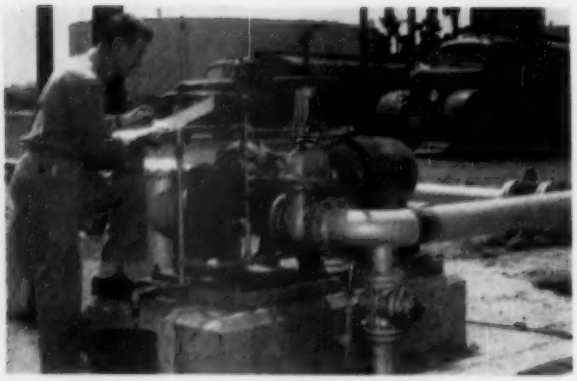
It has been suggested that operators in any given area establish minimum horsepower requirements for jet drilling to be sure they are using their pump power most efficiently. As an example of power requirements for different holes and drill strings, the Ark.-La.-Tex. committee has presented the following requirements for jet-bit drilling a 6,500-ft. well:

Assuming:

Minimum nozzle velocity: 200 ft. per second. Minimum annular velocity: 100 ft. per minute

Mud weight: 10 lb. per gal. Three 6¼-in. o.d. by 2¼-in. i.d. by 30 ft. drill collars.

Pipe size, in.	4½ F.H.	3½ I.F.	3½ I.F.
Hole size, in.	8¾	7⅞	8¾
Flow rate for above annular velocity, g.p.m.	230	200	260
Approximate nozzle area for above nozzle velocity, in.²	0.390	0.330	0.440
Calculated pressure losses to 6,500 ft., psi.	655	955	1,215
Hydraulic horsepower required	88	112	184
Input pump horsepower (90 per cent pump efficiency and 85 per cent engine efficiency)	115	146	240



A 6" double suction Goulds pump in the Norfolk, Va., plant of Cities Service Oil Company.

They chose

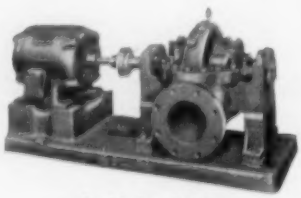
pumping capacity

Here's how you can get capacity...or head...or both

CAPACITY: When Cities Service Oil Company outfitted their Norfolk Terminal with pumps, their prime interest was capacity.

They needed a pump that could service four truck-loading assemblies, tank cars and small boats, swiftly and dependably.

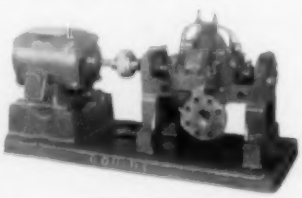
They chose the 6" model of this single stage suction pump. It gives them a full 1,100 GPM under a 60-foot head. The largest of the 19 pumps in this series pumps 6,400 GPM under a 280-foot head.



Goulds Fig. 3405

HEAD: If you're looking for greater pressure rather than just capacity, there are five models of Goulds Fig. 3305 two stage pump that provide heads up to 1,000 feet with capacities to 1,200 GPM.

BOTH: If you're looking for both head *and* capacity, either in combination or for different jobs, you have 24 models to choose from. Since most parts are interchangeable among the different pumps, you can cut parts inventory by as much as one-half or even more.



Goulds Fig. 3305

There are many other problem-solving features in these pumps. To get the complete picture send for: Bulletin 721.6 on the single stage pump and Bulletin 722.6 on the two stage.

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Pipeline Patrol

. . . Report on Construction

PIPELINE activity reported here is compiled from surveys conducted by The Oil and Gas Journal among pipeline companies and contracting firms. Projects listed include those proposed, contracted, and under way. Uncontracted projects are indicated by ● preceding the project.

Crude-Oil Pipelines

Buckeye Pipe Line Co.—Will complete in October or November 1956, own reconditioning of 191 miles of 8-in. from Griffity, Ind., to Lima, Ohio.

Cities Service Oil Co. & Subsidiaries.—Rerouting of 6 miles of 8-in. north of and through Ponca City, Okla., to be completed by Roy L. Johnson, April 30, 1956.

Lakehead Pipe Line Co., Inc.—Let 51 miles of 26-in. looping in Minnesota and North Dakota, to Anderson Brothers Corp. Job to be completed summer of 1956, is in conjunction with 69 miles of 24 and 26-in. looping to be completed this summer by Interprovincial Pipe Line Co. (See Interprovincial, foreign crude.)

● **Magnolia Pipe Line Co.**—Plans 14 miles of 16-in. from Ringgold to Addington, Tex., to be completed June 1, 1956. Plans a 22-mile, 8-in. gathering system, plus 3 and 4-in. laterals in Nolan County, Texas, to be completed May 15, 1956. Plans 36 miles of 12-in. from Andrews to Midland, Tex., to be completed January 1, 1957.

● **Offshore Gathering Corp., Houston.**—Proposes a natural-gas and a crude-oil line, each about 364 miles, to gather gas and crude in Gulf of Mexico off Louisiana. Gas line to be 60 miles of 24-in., 70 miles of 26-in., 234 miles of 30-in. Crude line to be mostly 20-in.

● **Pasotex Pipe Line Co.**—Plans 75 miles of 20-in. along its route from Wink to El Paso, retiring another dual 8-in. section.

● **Shannon Oil Co., Denver.**—Plans with Farmers Union Central Exchange, Inc., and Mule Creek Oil Co., both of Billings, Mont., a 34-mile, 6-in. line from Murphy Dome in Hot Springs County, Wyoming, to contact Ohio Oil Co.'s line in Big Horn County. Construction to start in August, end by December 1, 1956.

● **Sinclair Pipe Line Co.**—Building a 300-mile line from Jacksboro, Tex., to Houston. River Construction Corp. has 152 miles of 18-in. from Jacksboro to Teague, Tex., to be completed April 25, 1956. Two spreads are working: H. C. Arthur, superintendent, office at Weatherford; E. L. Maggard, superintendent, office at Hillsboro. Remaining 150 miles of 20-in. not yet let.

● **Tecumseh Pipe Line System.**—190 miles of 20-in. will be built by Sinclair Refining Co., Pure Oil Co., Ashland Oil & Refining Co., between East Chicago and Cygnet, Ohio.

● **Union Oil Co. of California.**—Proposes 815-mile line from Rifle, Colo., to Los Angeles refining area, to carry products from its proposed Rifle shale-oil plant.

Products Pipelines

● **American Pipe Line Co.**—Received ODM approval to amortize 40 per cent of $178,000,000 with a rapid writeoff on proposed line from Gulf Coast area to New York City area.

Buckeye Pipe Line Co.—Will complete in July 1956, conversion of 32 miles of 8-in. crude line between Mantau and Ellsworth, Ohio, to products line.

● **Cities Service Oil Co. & Subsidiaries.**—Plans a 10-mile, 6-in. L.P.G. line from Maysville to near Pauls Valley, Okla., to tie in to Shell line moving on to Cushing, Okla.

Cosden Petroleum Co.—Let 100 miles of 6-in. from Big Spring to Abilene, Tex., to C. O. Holder Construction Co. of Snyder, Tex., to be completed April 30, 1956.

● **El Paso Natural Gas Co.**—Plans 240 miles of "larger than 6-in." to carry natural gasoline, butane, and propane, from its Midkiff natural-gasoline plant in Permian basin, Midland County, to El Paso.

● **Gulf Refining Co.**—Will build 45 miles of 8-in. from Pontiac Eastern Corp.'s planned refinery at Hattiesburg, Miss. (due on stream May 1957) to a connection with Plantation Pipe Line Co.'s system. No date set to start.

Interstate Oil Pipe Line Co.—Let 25 miles of 8-in. from 12 miles south of Shreveport to Bethany, La., to C. Wayne Fowler, Pipe Line Contractor, Inc., to be completed May 15, 1956.

● **Magnolia Pipe Line Co.**—Plans a 75-mile, 8-in. L.P.G. line from Hull to Texas City, Tex., and a 30-mile, 8-in. line from Andrews to Dollarhide, Tex., both to be completed January 1, 1957. Plans an L.P.G. line, 19 miles of 6-in., 3 miles of 4-in., from Beaumont to Orange, Tex. Completion date indefinite.

● **Phillips Chemical Co.**—Plans 50-mile, 4-in. ethylene line from Sweeny to Port Adams, Tex., to be completed October 1, 1956.

Phillips Pipe Line Co.—Let 64 miles of 12-in. from Sweeny, Tex., to Houston, to be completed June 1, 1956, by H. H. Null.

Plantation Pipe Line Co.—Let 327 miles of 18-in. from Baton Rouge to Helena, Ala., to Oklahoma Pipe Line Constructors, to start June 1. N. L. Arie, spread superintendent, office at Baton Rouge.

● **Shell Oil Co., Pipe Line Department, Pacific Coast.**—Plans to convert 13 miles of existing 4-in. gasoline line, and add 3 miles of new line, to move gasoline from Wilmington refinery to Los Angeles. To be completed January 1, 1957.

● **Sioux Oil Co.**—Plans 80 miles of 4-in. from its Newcastle, Wyo., refinery to Rapid City, S. D., to be completed late 1956.

Southern Pacific Pipe Line Corp.—Let 87 miles of 6-in., from its main line at Phoenix to Davis Monathan Air Force Base, to Engineers Ltd. Pipeline Co. Let 76 miles of 6-in. from near Phoenix to Luke Air Force Base, to Hood Construction Co. To be let: 14 miles of 6-in. from Colton, Calif., to March Air Force Base.

Sun Pipe Line Co.—Contracts let on 109 miles of 14-in. from Twin Oaks, Pa., to Newark, N. J.: Sheehan Pipe Line Construction, 90 miles from Twin Oaks to Plainfield, N. J.; Delaney-Missouri Valley Construction Co., remainder. Work to start May 1, end September 1956. The line, with 83,000-bbl. capacity, will replace present 8-in. line.

● **Sunflower Pipe Line System.**—Has Kansas Corporation Commission approval for 215 miles of 6-in. to move L.P.G. from six counties in western Kansas to Wichita.

Tennessee Gas Transmission Corp.—Contracts let for 200 miles, 6-in. L.P.G. line from Banquete, Tex., to Houston: Sheppard & Geiger Construction Co., section from Banquete to Port Lavaca; Oklahoma Pipe Line Constructors, 74 miles from there to Brazos River, Gene Gohring, spread superintendent, office at Bay City; Panama-Williams Co., section into Houston.

Texas Eastern Transmission Corp.—Has approval to abandon "Little Inch" gas line, convert it to products line with capacity of 235,000 bbl. daily.

Non-Petroleum Pipelines

● **American Gilsonite Co.**—Plans 70 miles of 6-in. from Bonanza, Utah, to Grand Junction, Colo., to carry slurry of gilsonite from mines to refinery now being built.

Pittsburgh Consolidation Coal Co.—Let to Williams Brothers, 180 miles of 10-in. from its mines in eastern Ohio to Cleveland Electric Illuminating Co.'s Eastlake power plant northeast of Cleveland. Work started April 1, 1956, on this first line to move coal, with Ford, Beacon & Davis, Inc., handling specifications, contracts, construction supervision.

Natural-Gas Pipelines

American Louisiana Pipe Line Co.—Let bulk of 1,121-mile line from North Tepetate, La., to Detroit. H. C. Price and Houston Contracting Co. have 770 miles of 30-in. from near Willow Run, Mich., to near Eudora, Ark. Work starts June 1 on 40 miles in Ohio. E. C. Norris, spread superintendent, office at Defiance. Work starts May 1 on 185 miles from east of Memphis, Tenn., to near Eudora, Ark.; W. H. Hayes, spread superintendent. Works starts May 15, on 85 miles working north from Eudora, F. A. Silar, spread superintendent. Brown & Root has 221 miles of 30-in. from North Tepetate to Arkansas-Louisiana border (which is subcontracted to Associated Pipe Line Contractors and Western Contractors), and 39 miles of 16-in. under-water line which it will lay itself.

● **Arkansas Louisiana Gas Co.**—Firm has announced long-range plans to build a $50,000,000 pipeline from the Texas-Louisiana coastal region to northern Louisiana. The line would connect with the company's present system.

● **Carolina Pipeline Co.**—This newly organized firm has applied to the South Carolina Public Service Commission for permission to distribute natural gas in central South Carolina. The firm plans to build $8,700,000 worth of distribution lines to 14 cities.

● **Carolina Natural Gas Corp.**—185 miles 8-12-in., proposed lateral lines off Transcontinental in North and South Carolina.

Cascade Natural Gas Co.—Firm has let contract to Engineering Construction Co., of Tulsa, for 400 miles of gas distribution lines in the State of Washington. The lines will range from ¾ to 12-in. and will be laid in the towns of Yakima, Grandview, Granger, Trosper, Sunnyside, Toppenish, Union Gap, Wahpato, and Zillah. Work will start April 1.

Cities Service Oil Co. & Subsidiaries.—M. L. Moore Construction Co. has 18 miles of 3 to 10-in. gathering system at Roberts Ranch near Odessa, Tex., to be completed June 15, 1956.

● **Coastal Transmission Corp.**—Has applied to FPC for permit to lay 565 miles of 22 and 26-in. from McAllen, Tex., to Baton Rouge where it would deliver to Houston Texas Gas & Oil Co.'s proposed line to Florida. Coastal also plans 272 miles of smaller gathering lines.

● **Colonial Natural Gas Corp.**—Company proposes to build two systems, one from the Houston-Lake Charles area to Miami, Fla., and the other in the Carolinas and Georgia.

● **Colorado Interstate Gas Co.**—R. H. Fulton has 238 miles of 22-in. from Laramie to

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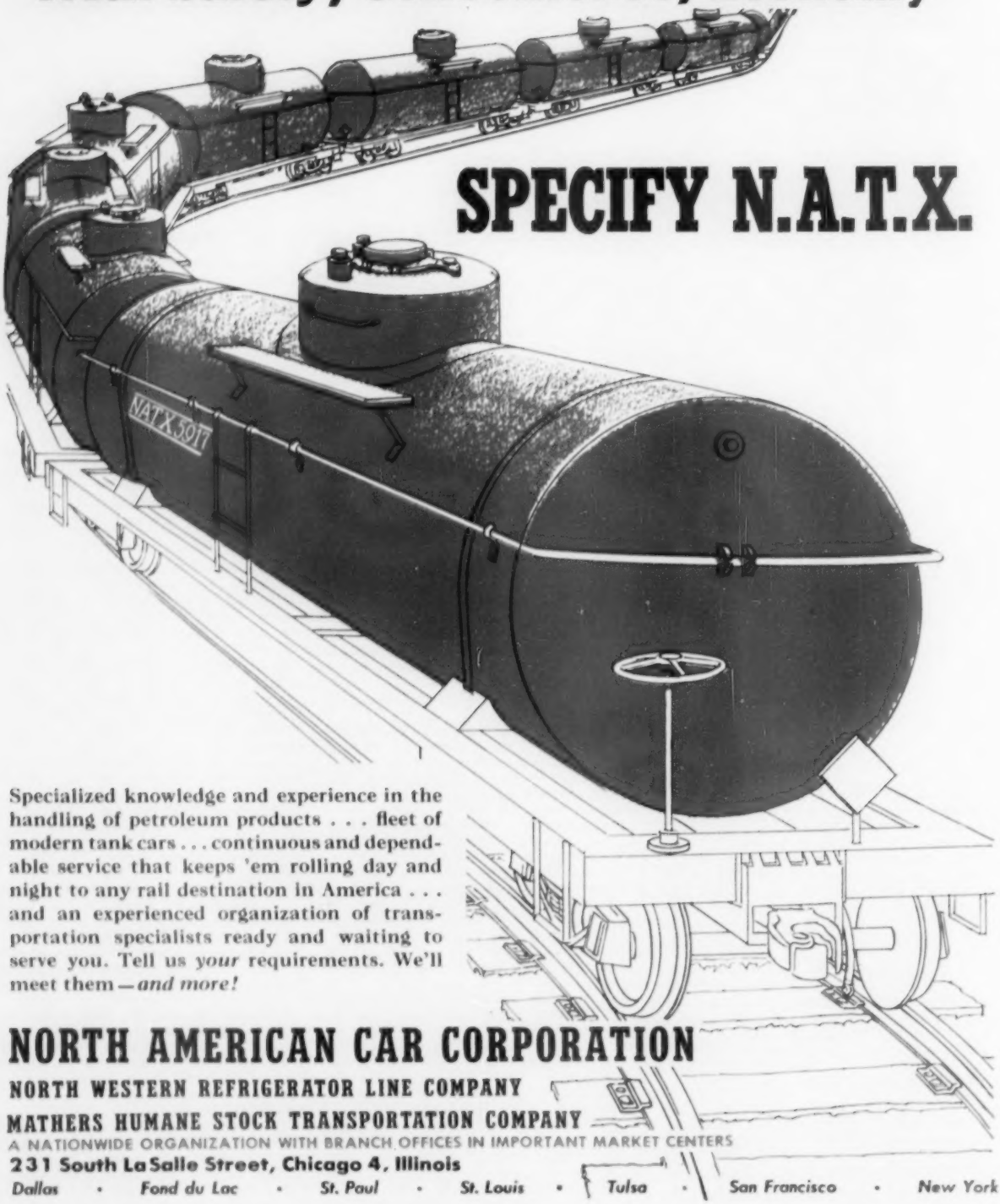

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Pipeline Patrol

Green River, Wyo. (last part of a 374-mile line between Denver and Rock Springs), to be completed fall 1956. Filed, March 29, for FPC permit for 1957 program: 307 miles of 30-in. from Idalia, Colo., to Beatrice, Neb., to take gas from a planned 165-mile, 26-in. line from near Carr, Colo., to Idalia, and from a 72-mile, 26-in. line from near Kit Carson, Colo. to Idalia; 215 miles of 20 and 24-in. to parallel present line from Texas Panhandle area to Kit Carson; 34 miles of 16-in. from Keyes field, Oklahoma, and Greenwood field, Kansas, to the new north-south line.

• **El Paso Natural Gas Co.**—Firm has received FPC permission to loop 450 miles of 34-in. line from the San Juan basin to the Colorado River at the Arizona-California border.

• **Empire Southern Gas Co.**—Plans a 10-mile, 8-in. line, and 5 miles of 4-in. gathering lines in Gray County, Texas, to be completed August 15, 1956. Plans a 4-mile, 8-in. loop south out of Pampa, Tex., on transmission line, and a 9-mile, 8-in. loop northwest out of Big Spring, Tex., on transmission line, to be completed June 1, 1956.

• **Houston Texas Gas & Oil Co.**—Company has applied to FPC for permission to lay a 960-mile gas line between Baton Rouge and Miami. The main line would consist of 507 miles of 30-in., 157 miles of 26-in., 61 miles of 20-in., 224 miles of 18-in., and 12 miles of 12-in. Company also plans 500 miles of sales laterals in Florida. Main line would join with Coastal Transmission's proposed line from McAllen to Baton Rouge.

• **Iron Ranges Natural Gas Co.**—This St. Paul company has filed an application with the FPC to build a 68-mile transmission line and 47 miles of laterals to supply various towns and cities on the Mesabi Iron Range in Minnesota.

• **Lone Star Gas Co.**—Company has two plans up before FPC to enlarge its system in Texas and Oklahoma. One is for an $18,000,000, 230-mile line from Cotton County, Oklahoma, to Fritch, Tex. The other plan is for a 205-mile line from Snyder, Tex., to a hookup with the Cotton-Fritch line.

• **Michigan Consolidated Gas Co.**—25 miles, 12-in., proposed, from near Sparta to Muskegon, Mich.

• **Michigan Wisconsin Pipe Line Co.**—251 miles, proposed, 24, 18, 12, 6, and 4-in. loops. Majority will be in Wisconsin.

• **Midwestern Gas Transmission Co.**—Company will build a main line from Portland, Tenn., to Canadian border near Emerson, Man., Canada. Extensions from main line to cities in Minnesota and Wisconsin are also planned. The main line will be comprised of 829 miles of 24-in., 109 miles of 16-in., and 174 miles of 12-in. The extensions will total 648 miles of 3 to 18-in. pipe. The application is now pending with the FPC.

• **Natural Gas Pipeline Co. of America.**—Has FPC approval for 350 miles of 20 and 26-in. from Jack and Wise counties, Texas, to Fritch, Tex., which will be contested by Natural Gas Pipeline and Lone Star Gas Co. Filed for FPC permit for a 389-mile, 36-in. loop along its line from Beatrice, Neb., to Chicago, to take gas from proposed line of Colorado Interstate Gas Co. Also for 91 miles of 30-in. looping to be laid along parts of its main line.

Nevada Natural Gas Co.—Company plans looping program along its 114-mile line from Needles, Calif., to Las Vegas, Nev.

Niagara Mohawk Power Corp.—Let to various contractors, 275 miles of 2 to 12-in. distribution mains for growth of service areas in Central, Eastern, and Northern New York, to be completed December 31, 1956.

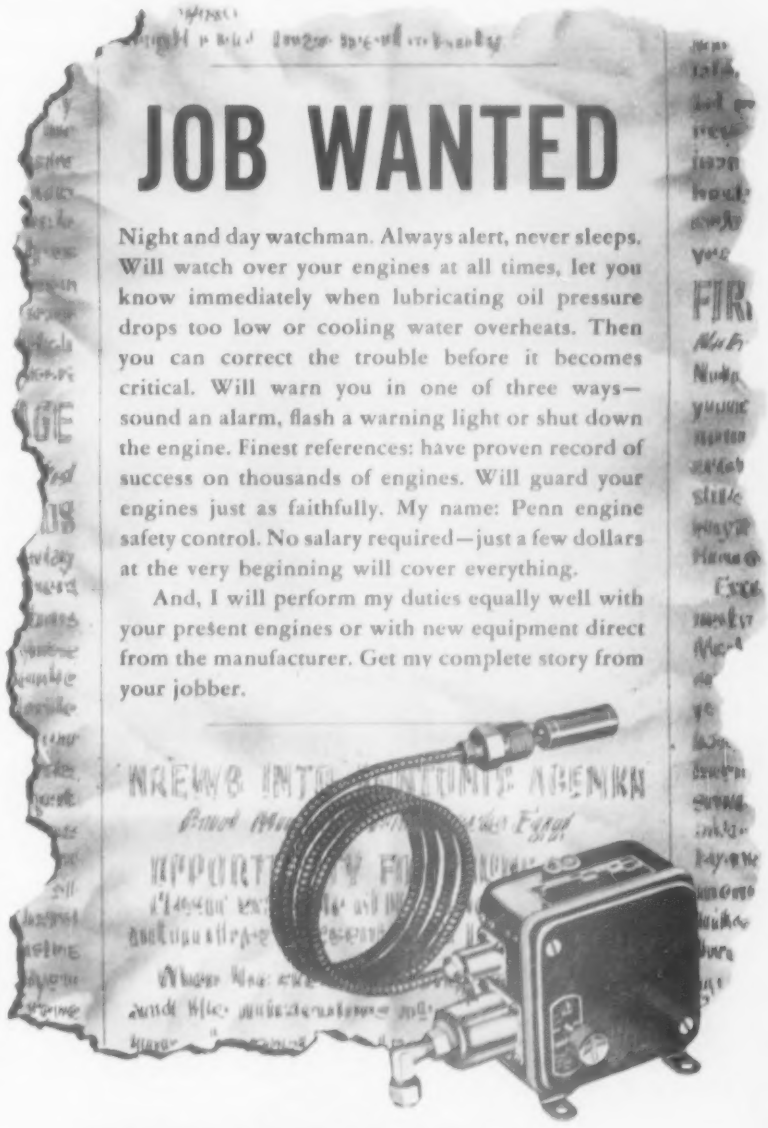
• **North Carolina Natural Gas Corp.**—This subsidiary of Colonial Natural Gas Corp. (formerly Texas-Ohio Gas Co.) has received permission from the North Carolina Utilities Commission to build 575 miles of gas lines in the state. The system will range in size from 3 to 16-in. and will cost about $13,000,000. The line will run from a point on Transcontinental Gas Pipe Line Corp.'s system near Mooresville, eastwardly across North Carolina.

• **Northern Natural Gas Co.**—Company plans to spend $32,000,000 to add 348 miles of main line and 307 miles of branch lines in Wisconsin, Minnesota, South Dakota, and Iowa. The application is before the FPC now. The main lines include 169 miles in the Duluth-Superior area and 164 miles in the Aberdeen area of South Dakota.

Also proposes a 73-mile, 20-in. line from Savanna Creek to Pincher Creek fields in Alberta, Canada, a 32-mile, 24-in. from Pincher Creek to Montana border, and 1,100-mile, 26-in. from Montana into Minneapolis.

• **Pacific Gas & Electric Co.**—Will build 37 miles of 20-in., 37 miles of 18-in., 9 miles of 12-in. from Beehive Bend field near Willows, Calif., to near Davis, then to Sacramento. Has under way a 6-mile gathering system at Beehive Bend. Also plans to loop the Topock-Milpitas line with 135 miles of 34-in., laying major part in 1956, and 62 miles in 1957.

• **Pacific Northwest Pipeline Corp.**—Has FPC permit for 37 miles of 6-in. from Dove Creek, Colo., to Nucla, and 13 miles of 4-in. from Nucla to Uravan, to serve Union Carbide Nuclear Co. and Vanadium Corp. of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America. Contracts let on other trunk and sales laterals:

A. P. V. Co., Inc., 81 miles 26-in. between Plymouth and Goldendale, Wash.

Engineers Limited, Inc., 56 miles 26-in. between Goldendale and Stevenson, Wash.

Midwestern Constructors, Inc., 79 miles 26-in. between Stevenson and Toledo, Wash.

River Construction Corp., 64 miles 26-in. between Toledo and Tacoma; also 16 miles of 18-in. out of Portland, Ore.

B & M Construction Co., 53 miles 26-in. between Tacoma and Duvall, Wash.

Curtis Construction Co., 87 miles 26-in. between Duvall and Sumas, Wash.

Hood Construction Co., 31 miles 6-in. near Walla Walla, Wash.

R. H. Fulton & Co., 156 miles 20 and 16-in. lateral from main line to Spokane; also 129 miles of laterals into Idaho.

Eastern Pipeline Contractors, 137 miles of 6, 8, 10-in. laterals from Plymouth to Wenatchee, Wash., to be completed July 1, 1956, L. Visentine, spread superintendent, office at Yakima.

H. B. Zachry Co., San Antonio, has contract for 42 miles of 4 to 16-in. line in the San Juan basin area of New Mexico. Pipe laying began in January.

Penn Fuel Gas Co.—Sheehan Pipe Line Construction Co. has 25 miles of 8-in. from Lewistown to Cross Keep, Pa., to be completed May 1, 1956. J. W. Brown, spread superintendent, office at Lewistown.

• **Permian Basin Pipeline Co.**—Has applied to FPC for 19 miles of 16-in. in Andrews County, Texas.

Phillips Petroleum Co.—Vaughn & Taylor has 135 miles of 20 to 2-in. gathering line in Central Oklahoma, to be completed June 1, 1956, and, with McVean & Barlow, 325 miles of 24 to 2-in. gathering line in West Texas, to be completed July 1, 1956.

Portland Gas & Coke Co.—United Engineers & Constructors, Inc., of Philadelphia, has engineering contract for 80 miles of various size lines up to 16-in.

• **Southern California Gas Co. and Southern Counties Gas Co. of California.**—Firms have plans for three separate jobs. First is 19 miles of 30-in. from Placentia to Compton, Calif. Completion set for November 1956. Second job is 70 miles of 30-in. from Palmdale to Alhambra, Calif., and completion is slated for November, too. Third job is 210 miles of 30-in. from Topock to Palmdale. Last job not expected to be finished before April 1957.

• **Southern Natural Gas Co.**—Company has temporary FPC authority to build 39 miles of loop lines and add 4,950 hp. to its compressor power near Atlanta, Ga.

• **Tennessee Gas Transmission Co.**—Projects:

192 miles of 24-in., 34 miles of 20-in., 15 miles of 18-in., 110 miles of 4, 6, 8, 10, and 12-in. laterals to extend gathering system from west of Crowley, La., to tie in to Tennessee Gas gathering line, eastward across southeast Louisiana, to mouth of Mississippi River, with laterals extending into Gulf of Mexico. Houston Contracting Co. has 162 miles in southern Louisiana: 25 miles of 24-in. to be completed April 15, spread superintendent, M. L. Thompson, office at Franklin; 25 miles of 24-in. marine line including the Atchafalavaz River crossing, to be completed May 15, spread superintendent, E. C. Norris, office at Morgan City; 25 miles of 24-in. marine line southwest of Cocodrie, spread superintendent, H. E. Murphy; 25 miles of 8 and 10-in. laterals south of Morgan City, to be completed May 5, spread superintendent, R. L. Silar; section east of Jeanerett toward Leeville. Williams Brothers

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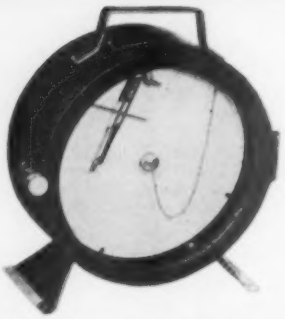

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HENINGER BLDG.
MONROE, LA.

PIPE LINE SURVEYS

SURVEYING & MAPPING

Pipeline Patrol

Co. has 55-mile, 24-in. marine job from Cocodrie, La., east of Bay Chalon area, spread man, W. A. Briley. Grayco Constructors, Inc., Associated Pipe Line Contractors, Inc., and Collins Construction Co. have remainder.

Has FPC permit for 74 miles of 30-in. looping from Cave City to Danville, Ky., and for 147 miles of 26-in. looping from east of New Boston, Ohio, and north of Ohio River to McConnellsville, and from Newcomerstown to Lisbon, Ohio, both to be completed fall of 1956.

Applied for FPC permit for 63 miles of 30-in. looping from Scottsville, Ky., to Cave City, and from southwest of Danville to northeast of Danville; for 99 miles of 26-in. looping from Greenup, Ky., to north of Ohio River, from McConnellsville to Newcomerstown, and from Lisbon, Ohio, to near Mercer, Pa.; for 100 miles of 4, 6, 8, 10, and 12-in. gathering line in Texas-Louisiana Gulf Coast area.

Tennessee Natural Gas Lines, Inc.—Walters & Prater has 9 miles of 12-in. looping including Cumberland River Crossing, Tenn., to be completed July 1, 1956.

Texas Eastern Transmission Co.—Company has received FPC permission to begin converting its Little Inch line from natural gas to products service.

Company asked the FPC late in December 1955 for permission to build a 422-mile, 30-in. line from McAllen to Beaumont, Tex. The line would be used to transport imported Mexican gas. The firm also asked the FPC for permission to loop 530 miles of its 30-in. line from Kosciusko, Miss., to Uniontown, Pa. The company will also lay 45 miles of 24-in. from Provident City, Tex., to connect in Matagorda County, Texas. This would tie the Wilcox Trend Gathering System in with the extension from Mexico.

• **Texas Gas Transmission Corp.**—Plans 110-mile, 20-in. from Assumption Parish to near Eunice, La. Will also lay 40 miles of various size pipe along main line from Louisiana to Illinois. Both to be completed December 1956. Plans 53 miles of 30-in. from Chicot, Ark., to Clarksdale, Miss., to be completed September 1, 1956. Plans reconditioning of 21 miles of 18-in. line near Wilmot, Ark., and Clarksdale, Miss., to be completed October 1, 1956. Williams Brothers Co. has 9 miles of 26-in. near Whitesville, Ky., to be completed May 31, 1956.

• **Trans Carolina Pipe Line Corp.**, Commercial Building, Raleigh, N. Car.—Seeks FPC permit for 300-mile system across North and South Carolina, plus 500 miles of laterals.

• **Transcontinental Gas Pipe Line Corp.**—Has applied to FPC to lay 160 miles of 36-in. and 68 miles of 30-in. loops from Louisiana to Pennsylvania., to be completed December 1, 1956.

Ashby Construction Co. has 11 miles of 12 and 16-in. gathering line in Vermilion Parish, Louisiana, to be completed April 30, 1956.

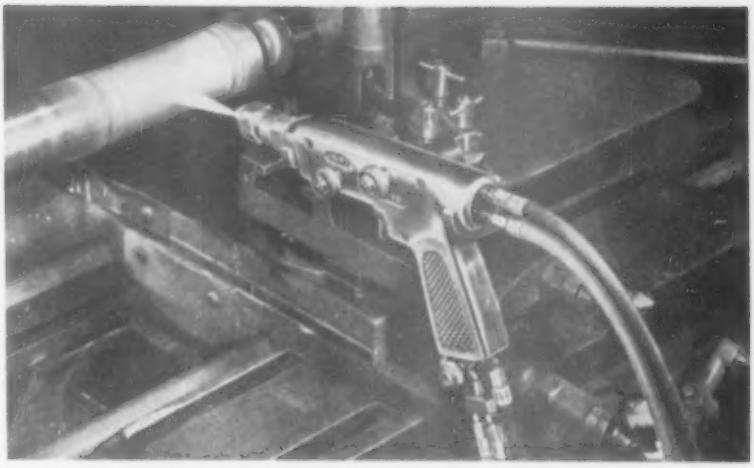
Foreign Crude-Oil Pipelines

Arabian American Oil Co.—Firm is building a 150-mile, 21-in. line from Safaniya field to near the Neutral Zone border.

• **Cremona Pipe Lines, Ltd.**—Has permit for 60-mile, 8-in. line from Sundre-Westward Ho region to Calgary. Company is subsidiary of Home Oil Co.

• **Esso, A. G.**—West Germany affiliate of Standard Oil Co. (N.J.) plans line from North Sea port to Rhur-Rhine area. This will probably be 120-mile, 10-in. from Rotterdam to Cologne, the latter rumored as the site of a new 58,000-bbl. refinery to be built by the company.

STOP CORROSION



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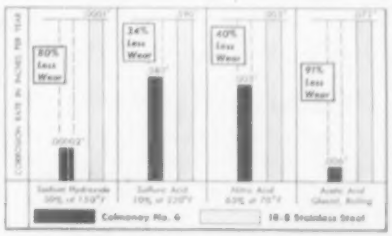
The superior corrosion resistance of Colmonoy No. 6 alloy makes it the ideal hard-facing material for use on metal-to-metal wearing surfaces operating under corrosive conditions.

The Colmonoy Spraywelder puts No. 6 on fast, in powder form. It makes smooth overlays within .010" of desired size, requiring a minimum of finishing. Sprayweld overlays are solid, non-porous, and welded to the base metal.

The corrosion of vital process equipment parts becomes needless waste when the wear resistant qualities of Colmonoy No. 6 are combined with the economy and ease of the Spraywelder. The answer to such waste by more and more cost conscious companies is "Stop corrosion with Colmonoy."



This table shows the comparative resistance to corrosion of Colmonoy No. 6 and 18-8 stainless steel. No. 6 is resistant to almost all caustics and acids. Ask for Engineering Data Sheet No. 3.

Write today for the Sprayweld Catalog and for Colmonoy Hard-Facing Manual No. 79, which describes all the Colmonoy hard-facing alloys and methods.

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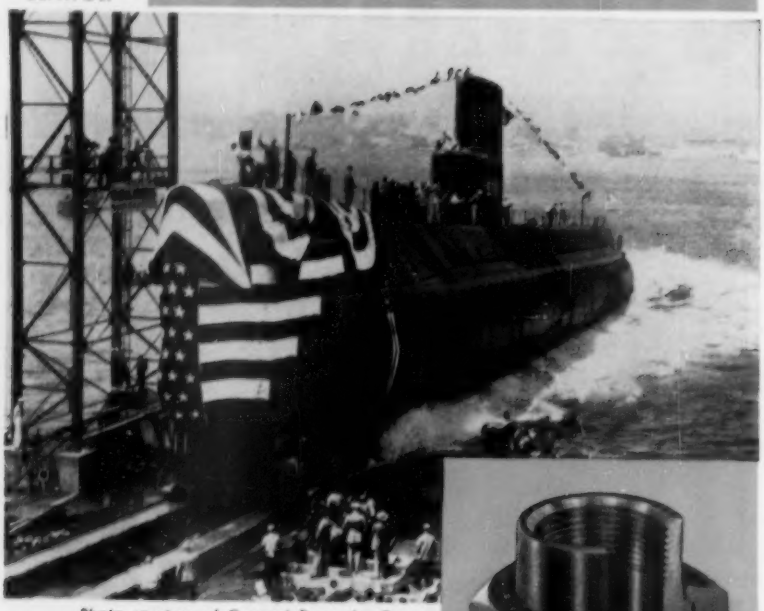

Photo courtesy of General Dynamics Corp.

LAUNCHING THE U.S.S. SEAWOLF at Groton, Conn., marked the development of the second atomic powered submarine built for the U.S. Government. Catawissa Valve & Fittings Co. is proud of its role in the project as major suppliers of Forged Steel Pipe Unions for the "Seawolf" — another repeat order in the atomic field . . . proof positive of satisfactory service!

SAFETY IS A "MUST"

From the original "Manhattan Project" to the U.S.S. Seawolf (and other unannounced atomic developments in private quarters), Catawissa Perfect Seal Pipe Unions have been specified to handle the extreme pressures involved. These are examples of "the toughest jobs", where absolute safety is a "must"!

3-TO-1 SAFETY FACTOR

One of the many extra value features of Catawissa Unions is in the very design itself — a design which gives each union a 3-to-1 safety factor. Catawissa 3000-lb. service unions, for example, are tested to 9000-lbs.; 6000-lb. service unions are tested to 18000-lbs., etc.

This point of superiority, plus expert workmanship and 40 years of experience, make Catawissa Forged Steel Pipe Unions and Swing Check Valves the best buy for rugged, trouble-free service wherever dependable performance is required.

PERFECT SEAL SEATING

Another Catawissa exclusive is its Ball-to-Angle seat design, which assures a Perfect Seal even when the two pipes joined are not in alignment.

ALL PRESSURES, TEMPERATURES

The Catawissa line is the most complete line of unions on the market—regular or special! They're hot forged from solid bars of AISI Spec. C-1026 steel, and meet the requirements of ASTM Spec. A-105, Grade 2.

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CATAWISSA • PENNA.

Pipeline Patrol

Ganso Azul Cia de Petroleo.—Company is building a 47-mile, 4-in. line from Agua Caliente field to Pucallpa, a port on the Ucayali River.

• **Gulf Italia Co.**—Firm is laying a 35-mile line from its Ragusa field in southwestern Sicily to a refinery at Augusta operated by RASIOM, an Italian company. The line size was not disclosed. Work is expected to be completed by the end of summer.

Interprovincial Pipe Line Co. — Majestic Contractors, Ltd., has contract for 67 miles of 24-in. and 2 miles of 26-in. along the company's system from Alberta to Sarnia, Ont. The Majestic work will be between Carroll and Somerset, Man., and 2 miles between the U. S. border and the Gretna pumping station. Work will be completed near the end of summer 1956.

• **Iraq Petroleum Co., Ltd.**—Company is making plans to lay a 75-mile, 24-in. products line from Homs, Syria, to Tripoli, Lebanon. The line would have a capacity of 180,000 bbl. daily.

• **Pembina Pipe Line, Ltd.**—Sparling Davis Co., Ltd., has 100 miles of 3 to 10-in. gathering system in Pembina field.

• **Sinclair Oil Corp.**—Company is considering a 240-mile crude-oil line from its San Silvestre field in the state of Barinas, Venezuela, to Puerto Cabello on the Caribbean Sea coast. The line would cost $25,000,000.

Westspur Pipe Line Co.—Firm has awarded contract to Majestic Contractors, Ltd., Edmonton, for 109 miles of 12-in. line from Midvale, Saskatchewan, to Interprovincial Pipe Line Co.'s pump station at Cromer, Manitoba. West spur has also let contract to same company for 50 miles of various size gathering lines in the Midale-Frobisher area of Saskatchewan.

Yacimientos Petroliferos Fiscales (Argentina).—Has started 700 miles of 12-in. from Campo Duran to San Lorenzo. TECHINT, (Compania Tecnica Internacional), Buenos Aires, has 90 miles.

Foreign Products Pipelines

• **Canadian Hydrocarbons, Ltd., Winnipeg**—Proposes 800-mile LPG line from Edmonton, Alta., to Winnipeg.

• **Chaco Pipeline & Refinery Corp.**—Firm plans to build 450-mile line from Glen McCarthy's wells in Bolivia to a new refinery to be built at Concepcion, Paraguay.

• **Imperial Oil, Ltd.**—Will lay 38 miles of 12-in. loop along present line from Waterdown, Ont., to Toronto.

• **National Iranian Oil Co.** — Company plans $32,300,000, 573-mile, 10-in. products pipeline from Ahwaz to Teheran, Iran. The line will have a capacity of 40,000 bbl. daily. Constain-John Brown, Ltd., London and Williams Brothers Co., Tulsa have southern 337 miles and pipelaying started in February. Entrepose of Paris has the northern 236 miles.

• **North Atlantic Treaty Organization (NATO).**—Laying products lines to airfields in various parts of Europe. About 2,000 miles of line will be laid. Bids were taken in January on 300 miles of 12-in. line between Marseille and Langres, France.

NATO—Associated Pipeline Contractors, Inc., Houston, is laying 450 miles of products line from Iskenderun, Turkey, to Batman, also in Turkey.

TECHINT (Compagnia Tecnica Internazionale), Milano, Italy, has 205 miles of 4-in. from Bandirma to Eskisehir, Turkey, and 250 miles of 8-in. from Antalya to Eskisehir.

The United States Defense Department.—Department is sponsoring a 485-mile, 8, 10, 12-in. products line from Cadiz to Zaragoza, Spain. The contract has been let to Merritt Chapman & Scott; Benson & Montin of Oklahoma City; and Agroman Construc-

Pipeline Patrol

tion Co., a Spanish firm. Brown-Raymond-Walsh is the prime contractor.

Foreign Natural-Gas Pipelines

• **Alberta Gas Trunk Line Co.**—Company will spend $47,000,000 to build 547 miles of gas-gathering system for the Trans-Canada line. The 1956 stage of construction will total 219 miles and cost $22,650,000. The first part would start near Saskatchewan and include Pincher Junction, Provost, Bindloss, Sibbald, Oyen, Sunnynook, Steveville, and Cessford. The second part to be built in 1957 will consist of 328 miles and cost $24,400,000. The second phase will include Countess, Duchess, Princess, Homglen-Rimbey, and Nevis.

Attock Oil Co.—Company plans to build 60-mile natural gas pipeline from Dhulian field to Rawalpindi in West Pakistan

Cia. Shell de Venezuela.—Company has announced plans for a $21,000,000, 177-mile, 20-in. natural-gas line from La Paz field in the Maracaibo district to the Cardon refinery on Paraguana Peninsula. The gas will be used as the chief fuel in the refiner's furnaces. The line is expected to go into operation in 1957.

• **Empresa Nacional del Petroleo.**—80 miles, 10-in., planned, Concon to Santiago, Chile.

• **Gas Industrial de Monterrey.**—Company has announced plans for a 22-in., 130-mile natural-gas line from Reynosa to Monterrey in northern Mexico. The project will parallel a 14-in. line which has been supplying Monterrey since 1947.

Imperial Oil, Ltd.—This Canadian firm has let contract for 65 miles of 4 to 16-in. gas-gathering system in the Redwater area of Alberta.

• **Magna Pipeline Co.**—Firm has plans to build a $6,000,000 underwater line from Anacortes or Bellingham in Washington to Victoria. The line is expected to be completed by the fall of this year.

North Canadian Oils, Ltd.—Dutton-Williams Brothers, Ltd., of Edmonton, has contract for 136 miles of 10-in. line from Wabumun to Hinton, Alta.

Clearing has started and pipe will start about May 1. Crossings of the McCleod River, Pembina River, and Wolf Creek are being made early.

South Alberta Pipe Line, Ltd.—Company has filed permit to construct a 150-mile, 8-in. natural-gas line from Etzikom field to serve a nitrochemical plant to be built near Medicine Hat, Alta.

• **Sui Gas Transmission Co.**—Pakistan Constructors, a joint company of Morrison-Knudsen, Boise, Idaho, and William Press, Ltd., London, have contract to build a 188-mile, 16-in. line from Sui gas field to Moultan, Pakistan. Work will begin in mid-1956. The line will later be extended to Lahore with branches at Kot Addu, Jhang, Magiana and Montgomery.

• **Trans-Canada Pipe Lines, Ltd.**—Firm extension of time limit to complete financing of 2,250-mile line from Alberta to Toronto and Montreal. New deadline is November 1, 1956. New deadline for exporting gas from Alberta is December 31, 1957. The Ontario government has agreed to help finance the line through its province. Tennessee Gas Transmission Co. has proposed a line to take gas from the company at Emerson, Man. (See Midwestern Gas Transmission Co.)

Westcoast Transmission Co., Ltd.—Company is starting work on a 650-mile, 30-in. line from the Peace River area in Canada to Sumas, Wash. Contractors are Mannix, Ltd., Canadian Bechtel, Ltd., R. A. Conyes Construction Co., and Dutton-Williams Brothers Co., Ltd. To be completed September 1957.

The Nation's Wildcatters continue to set new records . . . and more new sources of production are uncovered. Whether it's a Wildcat rig or just another well in a proven territory . . . Joe Roughneck, symbolic figure of the oil industry, is making hole . . . or calling the shots from the home office where he has become head man.

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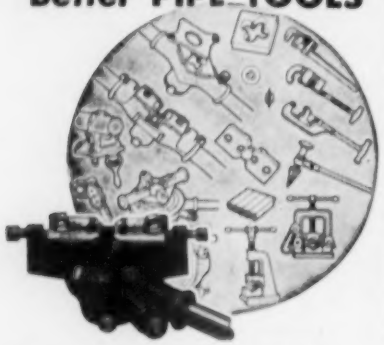

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Among the Drilling Contractors

Drilling Executives to Exchange Policy Views

Realistic bidding practices, supervision, communications, and public relations will be topics for round-table discussion at a drilling-executive conference at the Baker Hotel, in Dallas, May 9-11.

The three-day program is sponsored by the American Association of Oilwell Drilling Contractors in cooperation with the Petroleum Extension Division of the University of Texas.

Four conference leaders will moderate the discussions. M. L. Powers, University of Oklahoma, will be coordinator. He also will lead the sessions on "Fundamentals of Supervision."

Other conference leaders, and their topics for discussion are: Jack Magner, Rowan Drilling Co., Inc., Fort Worth, "Communications Needed in Preliminary Research for Bidding"; E. H. Sloyer, R. W. Rine Drilling Co., Wichita, "How to Bid Realistically and Get a Fair Portion of the Business"; and Eugene Whitmore, independent operator, Lockhart, Tex., "Selling Your Organization."

Conference leaders will place emphasis on individual participation in the discussions and exchange of viewpoints. Enrollment will be limited to 30 men to facilitate all present to take part.

This will be the first of a series of executive conferences the association plans to sponsor in various localities.

Rowan Drilling Co. has contract for Continental Oil Co.'s 1 State Lease 987, a 12,000-ft. Miocene wildcat in West Delta Block 82 area, off Plaquemines Parish, South Louisiana. The well is 7,500 ft. from the south line and 6,500 ft. from the west line of Block 82, West Delta area.

Murfin Drilling Co. will drill a wildcat in the NW NW SW 28-13n-5w, Kimball County, western Nebraska for Murfin & Sutton. It will be the 1 Kahl, 2 miles southeast of Boren field.

TGM Drilling Co. is moving a heavy-duty rig to the South Bell City area, 15 miles southeast of Lake Charles, in southeastern Calcasieu Parish, southwestern Louisiana, for a 12,500-ft. test it has contracted to drill for Michel T. Halbouty, of Houston. Halbouty's test, at 1 Stanolind Fee, in 15-11s-6w, is on the southeast side of the field. It is the south offset to a Gulf Refining Co. gas well. The field has four known productive sands between 10,430 ft. and 11,378 ft.

Coulston Drilling Co., Tyler, Tex., is keeping a rig working for Fair Redland Co., also of Tyler, in Redland field, Bossier Parish, northwestern Louisiana. Newest job is at 4-C Keoun and others, in 29-23n-12w, on the southwest flank of the field. It is another test to the 6,300-ft. Pettet pay.

Green & Heiser Drilling Co., Bakersfield, Calif., is under contract to E. A. Bender, Bakersfield operator, for a wildcat test in the Lerdo area, northwest of Rosedale Ranch field, 11 miles northwest of Bakersfield, in Kern County, southern California. Plans call for a test to about 7,500 ft. It is listed as 47-20 KCL, with location in 20-28-26.

Arrow Drilling Co., Dallas and Tulsa, has scheduled an 8,300-ft. Cotton Valley test to be drilled for Carter Oil Co. in the Liggin area, in northeastern Lincoln Parish, North Louisiana. Location, at I R. E. Norris estate, in 16-20n-2w, is 3½ miles northeast of Unionville field, nearest production.

Sunnyland Contracting Co., Rayne, La., has a rig running on a contract job nearly 4 miles northwest of Jonesville, in Catahoula Parish, eastern Louisiana. It is a 6,000-ft. wildcat test for Gauthier & Heard, of Natchez, Miss. Location is at 1 Cox, in 20-8n-6e.

Llano Drilling Co., Midland, Tex., has contracted for a 13,000-ft. offshore well to be drilled for Forest Oil Corp. in Block 42, Eugene Island area, Gulf of Mexico. Location is more than 20 miles from shore, off St. Mary Parish.

Kirkwood & Morgan, Alice, Tex., will drill a 7,500-ft. test 15 miles southwest of Tilden, in McMullen County, Southwest Texas. It is a contract job for Hugo Allen, of Corpus Christi, at 1 Craig, in J. Poitevent Survey 17.

Lamar Drilling Co., Shreveport, has a new 5,500-ft. operation 2¾ miles northeast of Lamar field, in western Madison Parish, northeastern Louisiana.

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Drilling is for Hudson Gas & Oil Corp., with location at 1 Z. C. Raburn heirs, in 21-16n-10e. Lamar is a Hudson affiliate.

Fortenbery Drilling Co., Natchez, Miss., is drilling for Serio-Punches Oil Co., also of Natchez, at 1 Donnelly, a 5,800-ft. Wilcox test in 16-6n-7e, northwest of Lismore Landing field, in western Concordia Parish, eastern Louisiana.

Falcon Seaboard Drilling Co., Tulsa, is starting another well for Sunray Mid-Continent Oil Co. in the South Glenwood area, in Beaver County, Oklahoma Panhandle. It is a 6,500-ft. contract to test to Morrow-Chester section. Location is for 1 Dillon-Lonker, in 25-6n-27eCM.

Kern-Trimble Drilling Co., Magnolia, Ark., is on a new wildcat operation Atlantic Refining Co. is starting 2½ miles northeast of Snow Hill, in southern Calhoun County, South Central Arkansas. It is a 5,100-ft. test to the Smackover. Permit is for 1 Calion, in 13-15s-15w.

Talbert & Hughey Drilling Co. has a new contract operation under way for Magnolia Petroleum Co. in West Slocum field, Anderson County, East Texas. It is another 6,500-ft. Woodbine well. Location is listed as 1 Killion, in the W. R. Wilson Survey.

Vick Well Service Co. is contractor on a new 4,600-ft. Woodbine test F. R. Jackson and Greenbrier Oil Co. are putting down at 1 Schulz, in the Antonio Lafflom Survey, 3 miles north of Sacul, in Rusk County, East Texas.

Jack Halbert Drilling Co. is drilling at a wildcat location 4 miles northwest of Canton, in Van Zandt County, East Texas. It is a contract job for Four W Oil Co. It is carried as 1 B. W. Bruce Estate, with location in the T. T. Havins Survey.

Norton Drilling Co. is keeping a rig busy in the New Bayou Villars field, Jefferson Parish, Coastal Louisiana, where it is drilling on contract for The California Co. Current operation, the seventh, is 7 State Lease 2704, in 15s-23e. Discovery well was completed last November. Production so far has been from an 8,500-ft. sand.

Iran Drilling Co. is drilling for F. R. Jackson, of Longview, Tex., at a wildcat location 3 miles southwest of Quitman, in Wood County, East Texas. It is a 5,400-ft. Woodbine test. Location is at 1 Champion, in the J. B. Tucker Survey.

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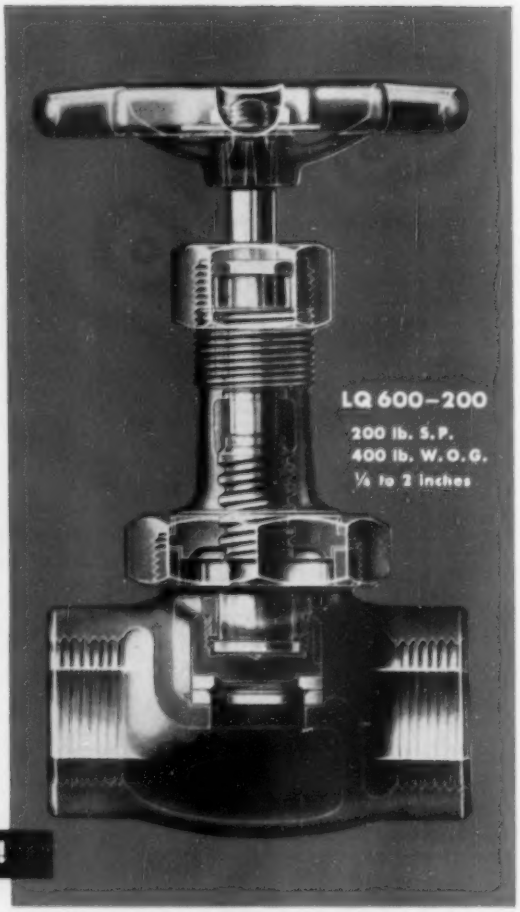

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EQUIPMENT MEN . . . in the News

Schlumberger Announces Sales Organization Shifts

Schlumberger Well Surveying Corp. has announced the following recent transfers of personnel: William H. Hartsell has assumed the position of manager of the Golden Meadow, La., location. J. B. Markolf has been named manager of the Midland, Tex., district office. J. A. Gilreath has assumed the position of manager of Schlumberger's Laurel, Miss., location. R. M. Chatham, Jr., has been promoted to manager of the Houston field location, having previously served as field engineer in both Houston and Beaumont. Frank A. Eastman has been promoted from field engineer to division engineer for the Texas Gulf Coast division, which has its headquarters in Houston. M. L. Millican, formerly manager of the field location at Midland, Tex., has been promoted to assistant to the division manager of the Permian Basin division, Midland. C. F. Grice has been named manager of Schlumberger's field location at Monroe, La.

W. H. HARTSELL

J. B. MARKOLF

R. M. CHATHAM

C. F. GRICE

Prior to his new appointment, Hartsell had served as manager of the Laurel and Brookhaven locations. Previously, Markolf was manager of the Wichita Falls location and assistant to the division manager of the Permian Basin division. Gilreath was transferred from Jennings, La., where he served as location manager.

Eastman will assist the Texas Gulf Coast division manager, I. L. Roberts, in matters pertaining to the technical quality of Schlumberger services. Grice previously served as a field engineer for Schlumberger in Magnolia, Ark., and Tyler, Tex.

Weatherhead Picks Sales Manager, Controls Division

The appointment of Morris P. Stillinger as sales manager of The Weatherhead Co.'s newly formed controls division has been announced by Morris H. Wright, vice president and general manager, Cleveland division.

Stillinger's initial responsibility will be the introduction and sales of a natural-gas-appliance regulator designed and manufactured by The Weatherhead Co.

During the past 17 years Stillinger has been in the utility and appliance fields. He was with Southern California Gas Co., The Carrier Corp., and Robertshaw Fulton's heating controls division. He will maintain his office in The Weatherhead Co.'s Cleveland, Ohio, headquarters.

Graver Tank Names L. J. Cogan as Sales Manager

The promotion of Leonard J. Cogan to the position of sales manager has been announced by Graver Tank & Manufacturing Co., Inc. Cogan, who will headquarter at Graver's Chicago office, will be responsible for all sales of Graver Tank & Manufacturing Co., Inc., with the exception of the Mid-Continent division, Graver Construction Co., Inc., and Graver Water Conditioning Co. In this new post, Cogan reports to W. M. Broxham, vice president for sales.

L. J. COGAN

Cogan previously was assistant manager of eastern sales with headquarters in Philadelphia. He served for a number of years with Lincoln Electric Co. as office manager at Philadelphia and later as a member of its sales department specializing in welding problems.

Bethlehem Holds First of Two Sales Meetings

The Bethlehem sales organization is shown during one of the general meetings. G. A. Tompson, president, is seated in front, and I. C. Smith, general manager of sales, is standing in the corner at the back of the room.

Bethlehem Supply Co. held the first of two annual sales meetings March 26 and 27 at its Tulsa plant. The meetings are being held primarily for discussion on the Bethlehem line of general-service pumps. The meeting also covered all other Bethlehem manufactured products.

The out-of-town personnel attending these two meetings totaled about 113. Included in this total were district managers, machinery sales representatives,

and store managers from all 71 Bethlehem stores and offices. Those company representatives who attended the first meeting were:

J. J. C. LeFlore, Lindsay, Okla.; R. F. Wyers, Duncan, Okla.; F. C. Beattie, Oklahoma City; N. G. Blankenship, Ponca City, Okla.; R. C. Neugent, Great Bend, Kans.; C. W. Young, Russell, Kans.; F. M. Matzke, Thermopolis, Wyo.; G. P. Pelissier, Casper, Wyo.; W. A. Nestlerode, Denver; I. H. Correll, Sterling, Colo.; A. D. Daniel and J. C. Green of Salem, Ill.; L. C. Graves and J. D. Hicks, Houston.

W. J. Vark, New Orleans, La.; D. G. Shanks, Harvey, La.; A. A. Webre, Houma, La.; R. E. Taylor, Morgan City, La.; W. R. Griffith, Corpus Christi, Tex.; A. E. Walter, San Antonio, Tex.; R. F. Landry, New Iberia, La.; E. T. Broughton, Great Bend, Kans.; W. L. Coleman, Ardmore, Okla.; P. W. O'Brien, Seminole, Okla.; S. G. Roegels, Abilene, Tex.; and J. J. Caskey, New Iberia.

J. V. Spalding, C. R. McNair, J. K. Davis, and O. H. Crowe of Houston; T. C. Graham, Corpus Christi, Tex.; W. T. Davis, Oklahoma City; R. A. Johnson, Wichita, Kans.; J. G. Floyd, Shreveport, La.; D. C. Thomas, Fort Worth, Tex.; W. E. Stephenson, Wichita Falls, Tex.; Wendell M. Jones and J. R. B. Freeman of Los Angeles; G. O. Denton and L. J. Nelson, Kilgore, Tex.; W. Q. Mitchell, Shreveport; H. T. Dodgen, Winnsboro, Tex.; G. H. Underwood, Wichita Falls.

H. L. Dodds, Sweetwater, Tex.; W. A. Langbein, Dallas, Tex.; D. L. Ligon, Graham, Tex.; L. K. Roberts, Amarillo, Tex.; R. O. Hall, Borger, Tex.; R. E. Lee, Artesia, N. M.; L. E. Garner, Hobbs, N. M.; B. K. Smith, Midland, Tex.; J. E. Guy, Snyder, Tex.; H. C. Edgeman, Odessa, Tex.; E. C. Delaune, Sundown, Tex.; Austin Moore, Odessa, Tex.; Arthur Weber, Jr. and R. H. Gault, Midland, Tex.

The sales meetings are under the supervision of I. C. Smith, general manager of sales.

ADD 10 YEARS LIFE TO YOUR WELL CASING

WITH VIBRA-PAK ANODES

You can't afford to be without this protection a day longer! Right now corrosion is eating away your well casing . . . before long, expensive repair and replacement will be necessary.

This corrosion can be stopped by installing VIBRA-PAK anodes. Think of the savings this will mean!

Vibra-Pak anodes are best because they are designed and made to combat the specific corrosive conditions of the soil around your well. Vibra-Pak anodes are spectrographically analyzed to assure exact specifications, they have a thin, solidly bonded spiral core to assure longer life and their exclusive backfill material means more efficient operation.

Our engineers will survey your wells, take soil resistivity tests and make recommendations . . . all without obligation.

Standard Magnesium Corporation

P. O. BOX 1424J • TULSA, OKLAHOMA

Bacher Is Sales Manager Of Winslow Engineering

J. F. BACHER

The appointment of John F. Bacher as sales manager of Winslow Engineering Co. was learned by distributors of Winslow filters and elements at their national sales meeting in Oakland, Calif. After serving as a sales representative, Bacher was named western division sales manager, working out of the home plant in Oakland and a newly established factory in Murray, Ky. Prior to his affiliation with Winslow, he had been with an air-cleaner organization in Portland and had been its branch manager in Denver.

Bacher's appointment was announced by Charles A. Winslow, founder and president of the 33-year-old filtration-equipment firm. The announcement highlighted a meeting also marked by the presentation of technical papers by Winslow, Vice Presidents Laurence L. Moore and William G. Nostrand, and other executives in the company's domestic and export sales organizations.

Gustin-Bacon Makes Schultz Area Sales Representative

The appointment of Sheldon Schultz as sales representative, industrial department, for the Oklahoma, Kansas, and Texas territory, has been announced by Gustin-Bacon Manufacturing Co.

Schultz, formerly with The Mud Products Co., will be responsible for the sale of the company's Rolagrip, Gruvagrip, and Gruvajoint pipe couplings and fittings to the oil industry. The Rolagrip couples plain-end pipe; and Gruvagrip and Gruvajoint cou-

EXCEPTIONALLY HIGH RESISTANCE TO

- FLUID CUTTING
- WEAR
- CORROSION
- ELECTROLYTIC ACTION
- BALL POUNDING
- BALL-ON-SEAT SHOCK

That's what you get with KENNAMETAL* Balls and Seats

You can reduce sub-surface pump failures and costly pump pulling jobs due to worn out balls and seats by installing Kennametal Balls and Seats. Kennametal gives you from 3 to 5 times longer service than special or super alloys and 20 times the service of steel balls and seats.

Get Performance Like This

- Kennametal wear parts in an Otis bottom hole regulator provided 12,000,000 closures under 1200 psi in sand-laden fluid.
- After over 2 years of service, Kennametal Balls and Seats are still operating in a Houston field, where the corrosive and abrasive conditions forced pump surfacing 3 times in 4 months to replace alloy balls and seats.
- In a Ventura Avenue well, strongly corrosive cuts destroyed the effectiveness of the best alloy steel balls and seats in three weeks' service. Kennametal Balls and Seats were installed over a year and a half ago. Already they have outlasted the best alloy steels by 26 to 1, and they're still on the job.

If you have a problem well, or just want longer life, less pump downtime, ask your pump service man to install Kennametal API Balls and Seats. They will cost you less in the long run. KENNAMETAL INC., Latrobe, Pennsylvania.

*Registered Trademark 7283

INDUSTRY AND **KENNAMETAL** ...Partners in Progress

Longer pump life, less downtime, lower pump cost

DARCOVA PUMCUPS

now available with

100% NYLON COMPOSITION

for HYDRAULIC CONTROLS, AIR CYLINDERS, RECIPROCATING PUMPS

Darcova Pumcup

Darcova 45° Bevel Type Pumcup

DARLING Pumcups—long noted for unequalled efficiency and life in all kinds of cylinders—are now greatly exceeding their own performance records! The new 100% Nylon Composition, available *only* in Darcova Pumcups, does it!

Nylon Pumcups are made in sizes, types and textures exactly right for your particular equipment—ready *now* to give you unprecedented piston packing performance!

Write for helpful data Bulletin No. 5503.

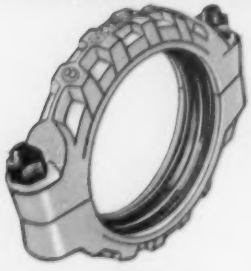
DARLING VALVE & MANUFACTURING CO.
Williamsport 1, Pa.

DARCOVA THE ORIGINAL COMPOSITION CUP
TRADE MARK **PUMCUPS**

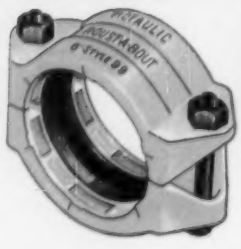
VICTAULIC®

METHOD OF PIPING

VICTAULIC HAS EVERYTHING...



VICTAULIC COUPLINGS
Simple, fast, reliable. *Styles 77, 77-D,* for standard uses with steel or spiral pipe, — *Style 75* for light duty. Other styles for cast iron, plastic and other pipes. Sizes ¾" to 60".

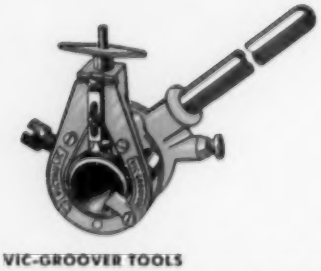


ROUST-A-BOUT COUPLINGS
For plain or beveled end pipe *Style 99.* Simple, quick, and strong. Best engineered and most useful plain end coupling made — takes a real "bull-dog" grip on the pipe. Sizes 2" to 8".

VICTAULIC SNAP-JOINTS
The new, boltless, speed coupling, *Style 78.* Hinged into one assembly for fast piping hook-up or disassembly. Hand locks for savings in time and money. Ideal for portable lines. Sizes 1" to 8".

COUPLINGS FOR EVERY PIPING JOB

VICTAULIC FULL-FLOW FITTINGS
Elbows, Tees, Reducers, Laterals, *a complete line*—fit all Victaulic Couplings. Easily installed — top efficiency. Sizes ¾" to 12".



VIC-GROOVER TOOLS
Time saving, on-the-job grooving tools. Light weight, easy to handle — operate manually or from any power drive. Sizes ¾" to 8".

PLUS FITTINGS AND GROOVING TOOLS

"EASIEST WAY TO MAKE ENDS MEET"

Promptly available from distributor stocks coast to coast.
Write for NEW Victaulic Catalog-Manual No. 55

VICTAULIC COMPANY OF AMERICA
P. O. BOX 509 • Elizabeth, N. J.

plings are designed to couple grooved-end pipe and are used primarily for field hookups of manifolds and tank-battery connections.

Tellepsen Petro-Chem Names Construction Manager

H. L. (Hank) Watchous has been named construction manager of Tellepsen Petro-Chem Constructors, a division of Tellepsen Construction Co. of Houston, according to Emory E. Gose, Jr., vice president.

Associated with Tellepsen since 1944, Watchous has supervised construction of many major plants for the chemical, petroleum, and gas industries. He also has been in charge of building industrial plants and heavy marine installations in Mexico and Venezuela.

Two Agents Appointed For Cash Standard

The A. W. Cash Co., Decatur, Ill., has announced the appointment of two new agents for the Cash Standard line of automatic valves, controllers, governors, and regulators. They will also represent Cash Standard Stacon Corp., a subsidiary of A. W. Cash Co., for temperature regulators.

Representing Cash Standard in the western two-thirds of Tennessee and northeastern quarter of Arkansas is Hurston-Conaway, Inc., with main offices at Memphis and suboffices at Nashville and Little Rock.

The Cash Standard reresentative for the state of Utah is Thermal Engineering Co., Salt Lake City, Utah.

Catalytic Construction Observes Tenth Anniversary

Tenth anniversary of Catalytic Construction Co. was marked at a luncheon in Philadelphia for T. Ellwood Webster, president (front, center), with Vice President W. Graham Jamison and Alan T. Knight (rear left and center), with Catalytic since its founding. Others are Clarence H. Thayer, Sun Oil Co. vice president; C. G. Kirkbride, president of Houdry Process Corp., of which Catalytic is a subsidiary; and C. C. Peavy, Houdry vice president.

E. V. Hunt Joins Ebasco as Ass't. Construction Manager

E. V. HUNT

Eldon V. Hunt has joined the staff of Ebasco Services, Inc., as assistant construction manager in charge of pipeline and related activities throughout the country. Hunt has been with Ebasco before as a construction superintendent and managed the engineering and construction of the South Carolina Natural Gas Co. pipeline for Ebasco, who were the engineers for that project. He left Ebasco to become general manager of the Key City Gas Co. in Dubuque, Iowa, where he supervised the changeover of that system from manufactured to natural gas and the construction of additional distribution lines in an expansion of the system. He went to Canada as chief engineer for Alberta Trunk Line from Dubuque in 1954.

Hunt has been in gas and pipeline engineering, construction, and operations for 20 years and was employed by Colorado Interstate Gas Co. as chief dispatcher and as an engineer; by Ford, Bacon & Davis, Inc., as an assistant chief engineer and as division engineer on the construction of the Michigan-Wisconsin and Austin field pipelines; by Fish Constructors, Inc., as a division superintendent on the construction of the Transcontinental Gas Pipe Line and later as a district superintendent for Transcontinental on operations in Alabama and Georgia. He resigned from Transcontinental to go with Ebasco the first time as construction superintendent.

Fort Worth National Plans Capital Accounts Increase

Plans for a $3,375,000 increase to the capital of The Fort Worth National Bank will be presented to stockholders at a special meeting on April 17, according to an announcement by Estil Vance, president.

Forth Worth National Bank stockholders will be asked to vote on a proposed new issue of 150,000 additional shares of the bank's $10-par-value common stock. Under the proposal to be submitted, the bank would increase its capital stock from $7,000,000 to $8,500,000, its surplus account from $7,000,000 to $8,500,000 and a $375,000 addition would be made to the undivided-profits account. This increase would provide the bank with capital and surplus accounts totaling

JOHN ZINK CO.

JZ Presents the NEW

SERIES

DA

Combination

Oil & Gas

Burner

The series DA burner, designed for vertical or horizontal firing, incorporates a unique and *thoroughly tested* approach to trouble-free operation.

The design permits an infinite turn-down without flash-back on any calorific value gas, and it is possible to obtain a long, cylindrical flame or a very short, fat flame.

This burner coincides with the latest trend in firing pitch, in that the muffle tile can be kept above a red heat with very little gas.

The oil firing is completely divorced from the gas burner, which simplifies operation and maintenance. Heat release of approximately 500,000 to 700,000 Btu/foot of flame can be obtained on oil.

For detailed information on the new John Zink Series DA Combination Oil & Gas Burner, write for the free DA Bulletin.

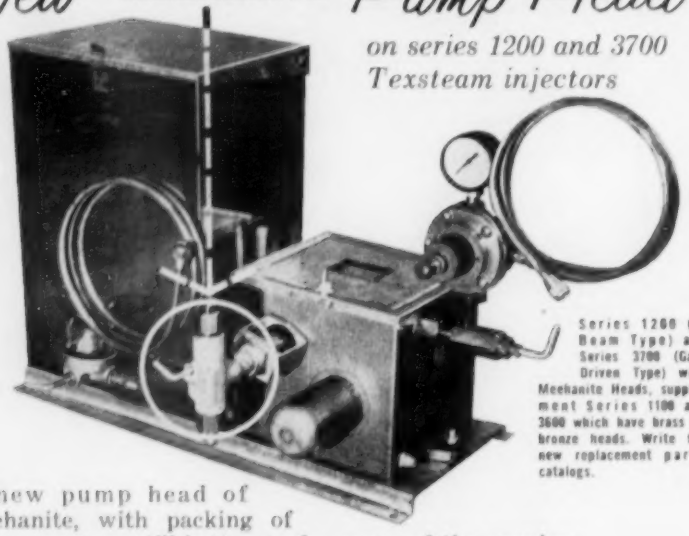
JOHN ZINK COMPANY

4401 So. Peoria **Tulsa, Oklahoma**

Oil & Gas Burners • Air Heaters • Field Flares

New MEEHANITE Pump Head

on series 1200 and 3700 Texsteam injectors



Series 1200 (S-Beam Type) and Series 3700 (Gas-Driven Type) with Meehanite Heads, supplement Series 1100 and 3600 which have brass or bronze heads. Write for new replacement parts catalogs.

A new pump head of Meehanite, with packing of Hycar, assures still better performance of the popular Texsteam Chemical Injectors.

The Meehanite head is a special iron casting, designed to withstand practically all compounds commonly used for emulsion breaking and corrosion injection service. It promises years of trouble-free duty.

TXT

TEXSTEAM CORPORATION

DIVISION OF VAPOR HEATING CORP.
320 Hughes St., Houston, Texas

This announcement is neither an offer to sell nor a solicitation of an offer to buy any of these Debentures. The offer is made only by the Prospectus.

$25,000,000

Plantation Pipe Line Company

Thirty Year 3½% Sinking Fund Debentures, Series due 1986

Dated April 1, 1956 *Due April 1, 1986*

Interest payable April 1 and October 1 in New York City and in Atlanta, Georgia

Price 100% and Accrued Interest

Copies of the Prospectus may be obtained from the undersigned only in States in which the undersigned is legally authorized to act as a dealer in securities and in which such Prospectus may be legally distributed.

MORGAN STANLEY & CO.

April 4, 1956.

$17,000,000 and a total capital, surplus and undivided-profits accounts of approximately $19,130,000.

H. M. Harper Co. Elects Channer Vice President

H. M. Harper, president of The H. M. Harper Co., Morton Grove, Ill., manufacturers of corrosion-resistant fastenings, announces the election of E. A. Channer to vice president of that company.

Channer joined the Harper company in 1939, served as Cleveland district manager, eastern district sales manager and general sales manager of the company. He will continue in this capacity as vice president in charge of sales.

Eastman Traces Directional Drilling on Denver Program

H. John Eastman, president of Eastman Oil Well Survey Co., whose headquarters are in Denver, recently made a guest appearance on the KOA radio program "Oil Today."

The program, sponsored by Denver National Bank, is a 15-minute program released each Saturday evening. It features prominent personalities in the oil industry and has received wide acceptance because of its educational and informative stories about oil operations, particularly in the Rocky Mountain area.

The interview with Eastman traced the history of Eastman Oil Well Survey Co. from its founding in 1930 in Long Beach, Calif., to its present-day international operations.

Of particular interest was the explaining of controlled directional drilling and oil-well surveying work by Eastman in California and the Gulf Coast areas and also how directional drilling is used to put out wild and burning oil wells.

H. John Eastman, president of Eastman Oil Well Survey Co.; Ken White, KOA-NBC news and special-events director; and G. W. Phelan, vice president and manager, oil loan division, Denver National Bank.

Baash-Ross Boosts Gearke To Ass't. Gen'l. Sales Mgr.

E. M. GEARKE

The appointment of E. M. Gearke as assistant general sales manager has been announced by Hal Messinger, general sales manager for Baash-Ross Tool Co., division of Joy Manufacturing. Gearke has been associated with the Baash-Ross organization for many years. Starting with the company as a sales representative, he was later made district sales manager of the Rocky Mountain area, and subsequently rose through various other executive capacities in the Gulf Coast, Mid-Continent and West Coast operations of the company. His experience also includes a hitch in western Canada as an executive with one of the major drilling contractors in that area before rejoining the Baash-Ross organization as Gulf Coast area sales manager. Gearke will headquarter in the Baash-Ross offices at Houston.

Delta Tank Appoints G. E. Freeman to Shreveport Area

G. E. FREEMAN

Appointment of George E. Freeman, Jr., as oil-field-equipment division sales manager in the Shreveport, La., area has been announced by Ross B. Baze, vice president of Delta Tank Manufacturing Co., Inc. Freeman previously was active in oil-field-equipment sales in Oklahoma City and Magnolia, Ark. Prior to that he was employed by Hunt Oil Co. of Palestine, Tex., and Shell Oil Co. in Magnolia.

Shelley Heads Newly Formed Dushell Engineering, Inc.

Organization of Dushell Engineering, Inc., Wichita, Kans., has been announced by F. Duane Fuqua, executive vice president, with Guy M. Shelley as president and treasurer. Dushell Engineering, Inc., is coordinated to perform petroleum-refinery, natural-gasoline and chemical-plant consulting and contract engineering. Services covering plant surveys, evaluation, and economic studies are also offered.

Shelley was for many years chief engineer of Winkler-Koch Engineering

WMSON THINSULATOR PAT. PENDING REG. U.S. PAT. OFF.

THE "RUGGED" THIN INSULATOR FOR PIPELINE CASING UNDER HIGHWAYS AND RAILROADS . . .

THINsulator band is of strong flexible steel

Round key blocks will not damage pipe coating

Synthetic rubber liner insulates pipe from casing

22" style 4 THINsulator shown here

- THIN INSULATOR—MORE COMPACT: MORE CLEARANCE THROUGH CASING
- EXCLUSIVE "SLING JOINT," WILL NOT DIG INTO PIPE COATING
- HIGH DYNAMIC AND STATIC LOAD CAPACITIES* WITH SOLID STEEL RUNNERS, MACHINE WELDED
- FLEXIBLE STEEL BAND, RUBBER LINED, FIRMLY GRIPS UNEVENLY COATED SURFACES

Solid steel runners are welded to band

*Stress analysis on 36" size 4 to 1 safety factor

SIZES: 2" through 36"

T. D. Williamson, Inc.

P. O. BOX 4038 TULSA 9, OKLAHOMA

REPRESENTATIVES: Houston • Pittsburgh • Plainfield, N. J. • Amarillo • Casper • Provo, Utah Joliet, Illinois • Los Angeles • San Francisco • Bartlesville, Okla. • Seattle • Edmonton London, Ontario • Calgary • Buenos Aires • Durban, Natal, South Africa • Paris, France

Co. and was instrumental in development of early thermal cracking units. While with Koch Engineering he directed mechanical engineering for complete refineries and refinery-process units in all parts of the world. More recently, Shelley formed his own company which does work in structural design, piping layouts, fueling systems, and refinery revamp work.

Fuqua was formerly vice president of engineering and engineering sales for Koch Engineering Co. More recently, he was in charge of European operations for Koch. Other members of the firm are Guy M. Shelley, Jr., whose experience includes refinery mechanical design and structural design; and R. J. King, chief mechanical engineer.

D+B Sales Meeting Attended by Engineers, Executives

The annual sales meeting of the D+B Division of Emsco Manufacturing Co. brought forth many constructive ideas for service to customers and was attended by all sales engineers and executive personnel of the D+B Division. Photo shows group in front of the administration building of the Garland, Tex., plant.

25 YEARS

of Experience in Correcting SCALE, CORROSION, ALGAE Problems

D. W. HAERING & CO., INC.

ANALYSTS · CONSULTANTS · MANUFACTURERS

SAN ANTONIO, TEXAS

Condit Appoints Reardon Sales Engineer in K. C.

Appointment of Robert C. Reardon as sales engineer covering all lines for The Condit Co. has been announced by D. J. Condit. Before joining Condit, Reardon was with Frontier Chemical Co., working with production and in the laboratory. Previously he was with Steam Plant Equipment as a sales engineer.

The Condit Co., with headquarters in Tulsa, also maintains offices in Kansas City and is a distributor for several lines of process and control equipment.

Weatherford Names Kercher To Oklahoma District

Weatherford Oil Tool Co. has recently named Robert F. Kercher district sales and service engineer for northern Oklahoma. Kercher will work from the company's Oklahoma City office.

Weatherford moved Kercher from its office in Fort Morgan, Colo., where he was involved in sales and service in the northeast part of the state. Kercher has been with Weatherford about a year. Prior to joining the oilfield specialties and service company, he was store manager for Franklin Supply Co. Before that, he was with Bethlehem Supply Co.

New Sales Managers Named By Gardner-Denver Co.

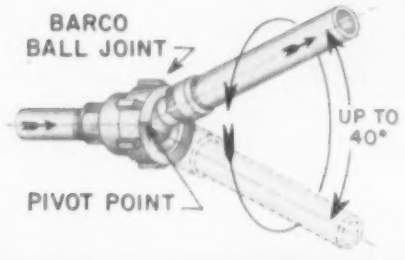
The appointment of William B. Knoderer as sales manager of the industrial division and Niel Martin Fishback as sales manager of the mining and contracting division of Gardner-Denver Co. has been announced by G. W. Gutekunst, general sales manager.

Fishback joined Gardner-Denver in

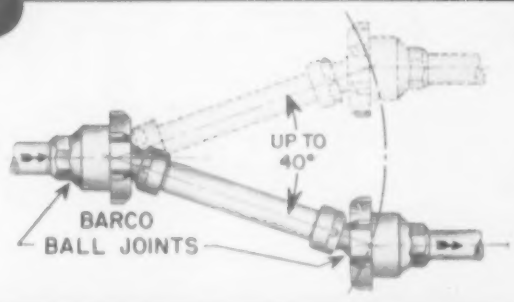
Barco Flexible Ball Joints

for solving piping problems { MOVEMENT • ALIGNMENT • EXPANSION
CONTRACTION • VIBRATION • SHOCK

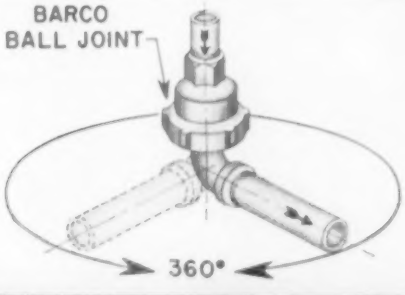
BARCO



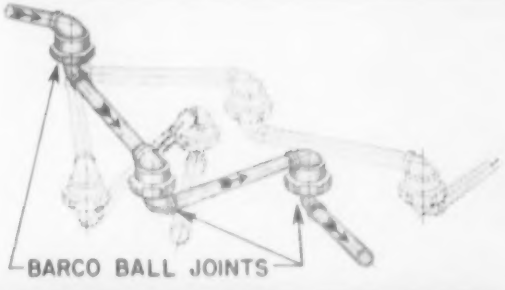
ONE JOINT—Provides for angular motion or positioning of piping in any plane. (Also see below.)



TWO JOINTS—This arrangement provides for piping alignment or simple flexible connection.



ONE JOINT—Allows for full 360° swivel or swing motion, in addition to angular movement shown above.



THREE (OR MORE) JOINTS—For complete flexibility. Any angle! Any radius! Any plane! Many arrangements possible.

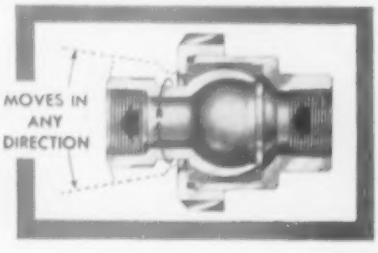
In Oil, Chemical, and Petrochemical Piping

THE four basic principles of motion illustrated above make the BARCO Flexible Ball Joint one of the most useful, most versatile fittings ever developed for piping conveying chemicals, oil, steam, water, air, and countless other fluids. *One joint often does the work of two or more ordinary swivel joints, because it moves in any direction!*

Metal pipe made flexible with Barco Flexible Ball Joints is practically indestructible. Long range planning calls for the permanence of this type of construction—*for freedom from maintenance and replacement, and SAFETY!*

There are many applications for Barco Flexible Ball Joints in industry: (1) To permit movement, (2) To accommodate expansion and contraction, (3) To provide for alignment, (4) To insulate against vibration and shock. For piping up to 12". Wide choice of styles and materials. *Let us give you the complete story.*

GET THE FACTS—New Catalog 2158 is an interesting, illustrated handbook on the application of Barco Flexible Ball Joints. Send for your copy NOW.



BARCO *Manufacturing Co.*

539E Hough Street • **Barrington, Illinois**

THE ONLY TRULY COMPLETE LINE OF FLEXIBLE BALL, SWIVEL, SWING, AND REVOLVING JOINTS

ALWAYS ON HAND...

WHEN YOU NEED US

Our fast, superior service . . . our nationally advertised products . . . our strategically located stores enable us to furnish you with supplies when you need them . . . day or night. Call your nearest United Supply store and see why our motto is "Courtesy . . . Service . . . Dependability."

UNITED SUPPLY

AND *Manufacturing* COMPANY

TULSA, OKLAHOMA

Stores in: KANSAS, OKLAHOMA, TEXAS, LOUISIANA, AND NEW MEXICO

COURTESY • SERVICE • DEPENDABILITY

1948 and served as district manager, El Paso branch, until his recent appointment. In 1955, Knoderer was moved to the home office of the company in Quincy, Ill., from Keller Tool Division at Grand Haven, Mich. He was sales manager of Keller Tool Co. before it merged with Gardner-Denver, and had served with Keller Tool since 1947.

Fluor President Elected Head, Cooling Tower Group

J. P. WISEMAN

James P. Wiseman, president of Fluor Products Co. of Whittier, Calif., has been elected president of the Cooling Tower Institute for 1956. The outgoing president is Neal B. LauBach of Hudson Engineering Corp., Houston.

Other officers elected for 1956 terms are: Forrest B. Reed of The Marley Co., Kansas City, Mo., vice president; Karl E. Johnson of J. F. Pritchard & Co. of California, Kansas City, Mo., secretary; and Denis E. O'Neil of Foster Wheeler Corp.'s cooling-tower department, San Mateo, Calif. treasurer. Also serving on the CTI executive board are Paul R. Hoffman of Lilie-Hoffman Cooling Towers, Inc., St. Louis, and Ennis C. Smith of Hudson Engineering Corp., Houston.

Executive offices of the Cooling Tower Institute, nationwide association of the major manufacturers of industrial water-cooling towers, are located at Palo Alto, Calif., under the direction of Raymond C. Kelly, executive manager.

Parks Is Republic Rubber Field Representative

Gordon Parks has been named a field representative for Republic Rubber Division, Lee Rubber & Tire Corp., Youngstown, Ohio. In announcing the appointment, G. L. Smith, Republic's general sales manager, said that Parks will headquarter in Denver, where he will be responsible for sales and service of Republic's line of hose, belting, packing, and molded and extruded products in the Rocky Mountain area. Republic sells primarily through industrial distributors.

Parks first joined Republic in 1953 as a product-development engineer. Prior to that he had spent 12 years with Gates Rubber Co. in various production and technical capacities.

Lane-Wells Reorganizes Divisional Organization

Lane-Wells Co. has reorganized its divisional organizations, according to James D. Hughes, vice president, sales and service. Division managers report directly to J. M. Henderson, manager domestic operations. Gulf Coast and Mid-Continent divisions are now divided into two regions, each with its own regional manager reporting directly to the division's manager of field services.

In the Gulf Coast division, E. A. Radack becomes manager of field services. J. P. Myers has been named regional manager for the northern region, which includes Ark.-La.-Tex. district, of which R. G. Grant is manager; the North Central Texas district, headed by W. A. Johnson, manager; and the West Texas district, of which J. W. Kiser is manager. Regional manager for the southern region is O. J. Guseman. The southern region comprises the Houston district with C. E. Shilcutt, manager; the southern Louisiana district with A. L. Boyd, manager; and the Southwest Texas district, R. A. Whittlesey, manager.

Ray A. Hancock has been appointed

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manager of field services in the new Mid-Continent-division setup. This division has been separated into an eastern region with J. E. Compton as manager, and a western division headed by Manager M. D. O'Haver. Three districts comprise the eastern region: the Illinois district, C. O. Ohl, manager; the Oklahoma district, J. F. Alexander, manager; and the Kansas district, with Ed Sayeas, manager. The western region also consists of three districts: the Farmington, N. M., district, J. D. Dunigan, manager; the Rocky Mountain district, L. C. Thaxton, manager; and the Williston district headed by Manager G. W. Long.

Kushubar and Pontier Added To R-M Sales Engineering

The appointment of Paul Kushubar and Wesley Pontier to sales engineering staff of Chief Engineer Guy E. Horvath has been announced by R. B. Hazard, sales manager, rubber and packing, Raybestos-Manhattan, Inc., Passaic, N. J.

Kushubar comes to the packing division from R-M's plant at Bridgeport, Conn., where he was a project engineer working on development and processing procedures of several product groups including compressed asbestos sheet packing.

Pontier has been with the Manhattan Rubber Division of Raybestos-Manhattan for 15 years. He has had experience in various manufacturing departments, and more recently in the industrial engineering department, specializing in production and methods procedure.

J. B. Gill Co. Names Knox Vice President-General Mgr.

DE WITT KNOX

De Witt Knox was recently named vice president and general manager of J. B. Gill Co., Long Beach, Calif. The appointment coincides with change in organization from a solely owned company to a corporation. Glen Gill remains as president.

The company, which has been serving the petroleum industry for 30 years, is a completely integrated organization of civil, mechanical, chemical, and petroleum engineers and constructors and offers complete service from design to finished construction.

Knox, who will have company management control, has worked on projects all over the world including the Philippines, Venezuela, South America, Cuba, Italy, and Iraq.

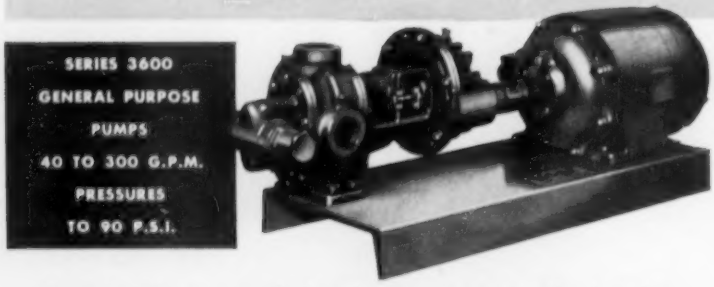
Pritchard Appoints Graves As Oklahoma Distributor

Ernest L. Graves Co., Tulsa, has been appointed sales representative in the state of Oklahoma by J. F. Pritchard & Co. of California, Kansas City, Mo.

Graves' experience includes work as a mechanical engineer for Shell Pipe Line Corp., section-head engineer for Standard Oil Co. of Indiana, and 7 years sales experience, the last 2 of which were spent as sales manager for a manufacturer's representative in Tulsa.

Corley Joins Cherokee Labs

W. T. (Dub) Corley, formerly with Stanolind Oil & Gas Co. in Lake Charles, La., has joined Cherokee Laboratories, Inc. of Tulsa, manufacturers of Tuf-Plug and other drilling-fluid additives. As technical representative of Cherokee, Corley will headquarter in Beaumont, Tex.



Once a well starts producing there are many applications in which a Roper serves best: for gathering line operations . . . tank truck transportation . . . field storage transfer. Ropers are positive displacement pumps (self-priming), and operate on the principle of two equal size gears running in axial hydraulic balance. This simplicity of design provides high pumping efficiency . . . smooth operation to reduce chatter and pulsation . . . and easy servicing right in the field. Packed box or mechanical seal models available. For your specific application, consult the Roper representative in your vicinity.

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Reed Named Tulsa Sales Manager for Enterprise

STEPHEN REED

Stephen Reed has been named Tulsa district sales manager for Enterprise Engine & Machinery Co. His territory covers Arkansas, Oklahoma, and the Texas Panhandle, particularly including service to diesel-engine requirements of the petroleum industry. The Enterprise district office in Tulsa is at Hotel Mayo.

In announcing Reed's appointment, A. W. Ostrander, general sales manager of Enterprise, noted that Reed has had industrial diesel experience in northwestern and southwestern states. His most recent assignment has been in contract sales for Enterprise at the firm's San Francisco home office.

R. F. MacDonald Co. Represents Cleaver-Brooks

Cleaver-Brooks Co., Milwaukee, Wis., has announced the appointment of R. F. MacDonald Co., San Francisco, as manufacturers' representative for the sale of Cleaver-Brooks boiler equipment. Its territory will include the northern half of California and the western half of Nevada.

Cleaver-Brooks manufactures equipment for the generation and utilization of heat.

Almoina Added to Failing Export Office Staff

A. L. (Andy) Almoina has been added to the export office staff of George E. Failing Co. in New York City as a sales representative, according to an announcement by J. T. Tucker, Failing's vice president in charge of sales.

Before joining Failing, Almoina was employed by the City of Miami and later by Westinghouse Air Brake International Co. of Pittsburgh, Pa.

McCullough Makes Maurath, Newashe Branch Managers

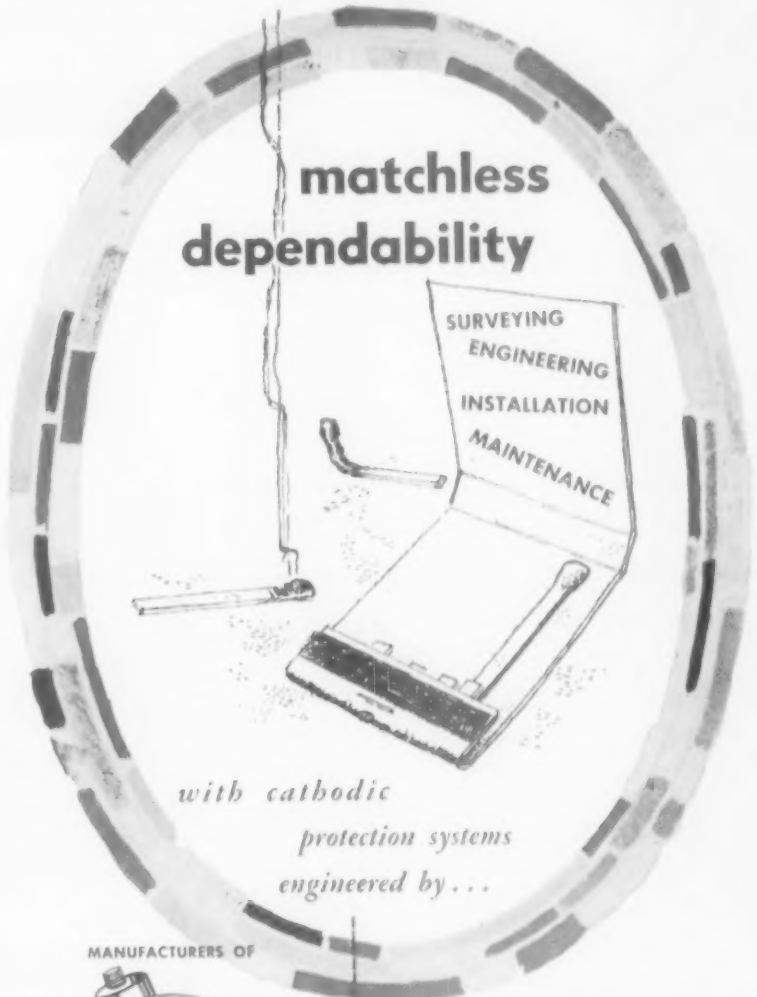
The appointment of W. P. Maurath as branch manager at Cody, Wyo., and naming of William Newashe, Jr., as branch manager at Kimball, Neb., have been announced by I. J. McCullough, president of McCullough Tool Co.

Maurath has been a sales engineer in McCullough's Cody branch since 1954. Prior to his transfer to Cody, he worked in the service department at Los Angeles gaining experience in line-truck-and logging operations. A veteran of 14 years in the oil business, Maurath has been employed by McCullough since 1941.

Newashe joined McCullough in 1949 at Casper, Wyo., as a qualified expert on wire-line services and fishing tools. He became branch manager at Cody in 1954. Newashe is one of seven branch managers in McCullough's mountain division serving oil men in four states.

Otis Transfers Suber To Corpus Christi

Speck Suber, former district superintendent for Otis Pressure Control, Inc., in Falfurrias, Tex., has been transferred to the firm's Corpus Christi division as district superintendent. Prior to joining Otis 12 years ago, Suber was in the field for Grady Vaughan, Sinclair Prairie, and other operators. He previously was stationed in the Otis branches in Corpus Christi and New Iberia, La.



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Work, Fun, Travel— These Will Occupy Oil Finders at Chicago

by Frank J. Gardner

CHICAGO will become the oil-finding capital of the world for 4 days next week.

Beginning April 22, the 12,000-man membership of the American Association of Petroleum Geologists and the Society of Economic Paleontologists and Mineralogists will forgather there in annual convention.

This summons to the opening session will greet delegates to the annual A.A.P.G.-S.E.P.M. meet in Chicago. Chester H. Lauck, now executive assistant for Continental Oil Co., will open the convention with 10 minutes of "Special Greetings from Lum."

A serious program . . . They've a very important problem to pursue this year—a study of the sealing factors in oil and gas reservoirs. A knowledge of these sealing elements is essential to better understanding of the reasons for oil accumulation in the numerous types of known traps, and can lead to new targets for exploration in virgin regions. Among these sealing factors are facies changes, unconformities, faults, cap rocks, and various types of permeability barriers. The oil finders will take a close look at all of them.

Possible future exploration methods and concepts will also be examined. This is of vital importance today in view of our so-called declining discovery rate. There's been no really important advance in this field since the birth of geophysics, but several are cooking, and geologists believe that an exchange of ideas along this line will be timely. There'll also be a symposium on the directional properties of sedimentary rocks, and the A.A.P.G. Research Committee will hold another symposium on porosity and permeability problems in carbonate rocks.

And an unique field trip . . . No rockhound is really happy unless he's chipping away with his hammer at an outcrop. At noon on Sunday, April 22, the unique opportunity to enlarge a rock quarry will be presented to the delegates. The huge quarry of Material Service Corp., at Thornton, Ill., some 25 miles south of Chicago's Loop, is said to be the finest exhibition of a Silurian coral reef in the world. It's not open to public inspection as a rule, especially by sample-happy geologists, but since it's soon to make way for a superhighway, the management has invited the conventioneers to give it the onceover on a field trip. Other field trips will visit Chicago's famous museums and galleries of art.

On the lighter side will be the selection of an official emblem. It's unusual for an organization to function for 40 years without an insigne of some kind, so the A.A.P.G. decided to do something about it. A contest was announced in the spring of 1955, and ideas were invited. The entries have poured in from all over the world, and at the Chicago meeting, the best designs will be displayed and a winner chosen.

Plus job interviews . . . While all this is going on, one corner of the convention hotel will be buzzing with interviews. Each year, as a part of the annual meet, the A.A.P.G. sponsors an employment interview center to bring together job hunters and man hunters. Previously, this service was operated primarily for students, but enough experienced men have appeared at past meetings to convince the officials of A.A.P.G. that it should be available to all geologists. Students from 250 different schools, and interviewers from 300 different employers are expected to take advantage of the employment center.

And new exhibits . . . Delegates will find more than 12,000 sq. ft. of commercial and educational exhibits. Equipment and supply companies will show the very latest wrinkles in geophysical equipment, drilling and well-servicing tools, field and laboratory materials, technical books, and maps. One exhibitor plans to have its mobile rig, a new type that can be fitted on the back of any vehicle, drilling away, right in the middle of the Conrad Hilton Hotel. The various geological surveys, societies, and university geology departments will present educational exhibits.

It won't be **all** work. The A.A.P.G. boasts some of the country's greatest jive hounds among its membership, and they'll be given an opportunity to shake a leg to the music of Ted Weems at a huge dinner dance and floor show on Wednesday night. There'll be teas, luncheons, fashion shows, and tours for the distaff side.

And after it's all over, the Northern Pacific Railway has offered to take the oil finders on a postconvention tour of the Williston basin to inspect developments there. A special train will leave Chicago on April 26 and for 6 days the travelers will transfer from trains to buses and back again as the Northern Pacific plays host.

All in all, it should be a busy week, and Chicago can claim that for a brief time, it was indeed the oil-finding capital of the world.

Don't Miss it!
'SPECIAL GREETINGS FROM LUM'
At the opening session, Monday 8:45 a.m.
Chester H. Lauck, the "Lum" of the famous team of Lum and Abner, speaks to the joint session Monday at 8:45 a.m. You won't want to miss this---
BE THERE ... AND BE ON TIME!

Texas Gas Reserves Gain 3 Billion Cubic Feet

by Charles A. Breitung
Oil and Gas Consultant, Austin, Tex.

THE proved recoverable reserves of natural gas in Texas as of January 1, 1956, are shown by the American Gas Association to be 108,287.5 billion cubic feet at 14.65 psia. and 60° F. The January 1955 recoverable reserves were reported as 105,129.0 billion cubic feet. Extensions and revisions accounted for the increase in volume.

In January 1946, the recoverable reserves were shown as 75,095.8 billion cubic feet. There has been an increase in reserves of 33,191.7 billion cubic feet from 1946 to 1956. The total new discoveries and extensions and revisions have amounted to some 67,235.1 billion cubic feet during that time. This represents an increase in volume of reserves of some 89.5 per cent during the 10-year interval, if marketable gas alone is taken as the basis of the net production. The gas consumed in extraction loss, plus gas vented, and plant meter differences for 1954 and 1955 would slightly increase the figure.

The dissolved and associated gas in the oil reservoirs and the gas caps of oil reservoirs is shown as 27,452.3 billion cubic feet, which represents approximately 25.4 per cent of the total recoverable gas reserves of the state based on by calculations. This figure can be revised upward, depending on what gas reserves are to be included in associated gas volumes. No doubt some of these associated gas reserves have been listed in this tabulation under the nonassociated gas reservoirs, as published by the Railroad Commission of Texas.

Marketable gas . . . Marketable production in 1954 and 1955 is the total gas to transmission lines, carbon-black, plant-fuel and lease use. Previous years included extraction loss and gas vented, amounting to 479.3 billion cubic feet, in 1955. The net gas for market has increased 2.2 times in the last 10 years.

In 1955, of the 4,454.1 billion cubic feet of marketed production, some 2,416.5 billion cubic feet of gas was exported from Texas, or around 54.2 per cent. This is a slight decrease in percentage over 1954 when 55.5 per cent was exported.

Reserves . . . The associated and dissolved gas reserves in Texas are located largely in some 63 major oil fields.

The nonassociated recoverable gas reserves estimated at 80,737.6 billion cubic feet as of January 1, 1956, are largely located in 22 major gas fields, most of which have multiple reservoirs, and represent about 74.6 per cent of the total recoverable gas.

TABLE 1—TEXAS GAS RESERVES BY GEOLOGIC AGE

Cambrien	Negligible
Cretaceous	14,369.2
Devonian	461.3
Eocene	15,147.6
Jurassic	43.4
Miocene	2,043.0
Mississippian	36.4
Oligocene	38,525.1
Ordovician	1,951.4
Pennsylvanian	12,497.6
Permian	9,412.1
Permian-Pennsylvanian	13,346.0
Pleistocene	0.4
Pleistocene-Pliocene	4.7
Pliocene	25.1
Pliocene-Miocene	37.3
Silurian	113.8
Miscellaneous	175.5
Total	108,189.9

Table 2—Major Texas Gas Reserves by Geologic Formations (by Districts)

(Billions of cubic feet—14.65 psia. at 60° F.)

Age and formation—	1	2	3	4	5	6	7-B	7-C	8	9	10	Total
Oligocene—Frio		2,588.8	13,252.8	14,992.2								30,833.8
Eocene—Wilcox	74.4	2,411.0	2,171.0	582.0								5,238.4
Miocene		397.4	1,369.2	236.2								2,002.8
Oligocene—Catahoula		188.3	467.1	366.7								1,022.1
Oligocene—Marginulina			1,246.1									1,246.1
Eocene—Cockfield			1,045.6									1,045.6
Eocene—Yegua		365.8	6,811.4	187.6								7,364.8
Oligocene—Anahuac		575.8	15.6									591.4
Oligocene—Vicksburg		377.7		3,672.3								4,050.0
Eocene—Jackson	2.1	28.2	63.1	1,044.7								1,138.1
Cretaceous—Woodbine			29.0		492.0	2,413.3						2,934.3
Cretaceous—Paluxy					8.4	455.8						464.2
Cretaceous—Rodessa, etc.					291.1	1,685.2						1,976.3
Cretaceous—Pettet					238.2	7,117.0						7,355.2
Cretaceous—Travis Peak					202.0	1,002.5						1,204.5
Permian—Wolfcamp							117.9	59.0	15.2			192.1
Pennsylvanian—Cisco							54.0	78.3	74.7	57.1		264.1
Pennsylvanian—Canyon							52.0	169.2	2,186.2	37.0		2,444.4
Pennsylvanian—Strawn	144.8						294.0	576.7	169.0	646.4		1,830.9
Pennsylvanian—Bend							200.3	5.0	5.6	1,124.2		1,335.1
Permian—(Grayburg)								293.2				293.2
Permian—San Andres								52.1	4,048.6			4,100.7
Permian—Clearfork								3.5	1,001.1			1,004.6
Permian—Spraberry								756.1	708.8			1,464.9
Devonian								2.0	459.3			461.3
Ordovician—Ellenburger							24.0	333.6	1,274.5	82.2		1,714.3
Permian—Whitehorse (Yates, etc.)									2,163.4		12.0	2,175.4
Permian											176.6	176.6
Permian—Pennsylvanian											13,346.0	13,346.0
Pennsylvanian											6,618.7	6,618.7
Total	221.3	6,933.0	26,470.9	21,081.7	1,231.7	12,673.8	742.2	2,328.7	12,106.4	1,946.9	20,153.3	105,889.9
Other formations	188.6	190.6	868.4	324.1	69.8	227.2	19.0	46.7	308.1	57.5		2,300.0
Total	409.9	7,123.6	27,339.3	21,405.8	1,301.5	12,901.0	761.2	2,375.4	12,414.5	2,004.4	20,153.3	108,189.9

There were as of January 1956 some 5,160 listed oil fields in Texas, and 1,755 gas fields. Texas had 11,793 gas wells which were producing gas and 111,644 oil wells reporting casing-head gas production at the first of the year.

The Texas gas reserves by geologic age are shown in Table 1.

It will be observed that the largest volumes of gas reserves are in the Oligocene, with most of the other volumes being in the Cretaceous, Eocene, Permian, and Permian-Pennsylvanian.

Future status . . . Future recoverable gas reserves yet to be discovered in Texas will likely include the tidelands areas off the Gulf Coast and the deeper gas-condensate reservoirs which will be discovered in all parts of the state.

At the present time the matter of federal regulation of natural-gas production has confused the situation, and no doubt will cause a decline in the new discoveries and in the development of gas reservoirs. In consequence there is apt to be a gradual decline in total recoverable gas reserves over the next few years, or until free competition with other fuels in the open market has been reestablished.

The present recoverable gas reserves in Texas represent approximately 22 years' supply at current levels of production, and without new discoveries and field extensions and revisions. It would be difficult to predict what the situation will be in 1966, 10 years from now, because of the conflicting issues involved. However, it can be said in passing, that the expansion of Texas industries will go forward at a greatly accelerated pace. This will have a tendency to keep more Texas gas for use in the Texas market.

The recoverable gas reserves in Texas have been listed by counties, and an attempt has been made to tabulate the reserves by geologic formation.

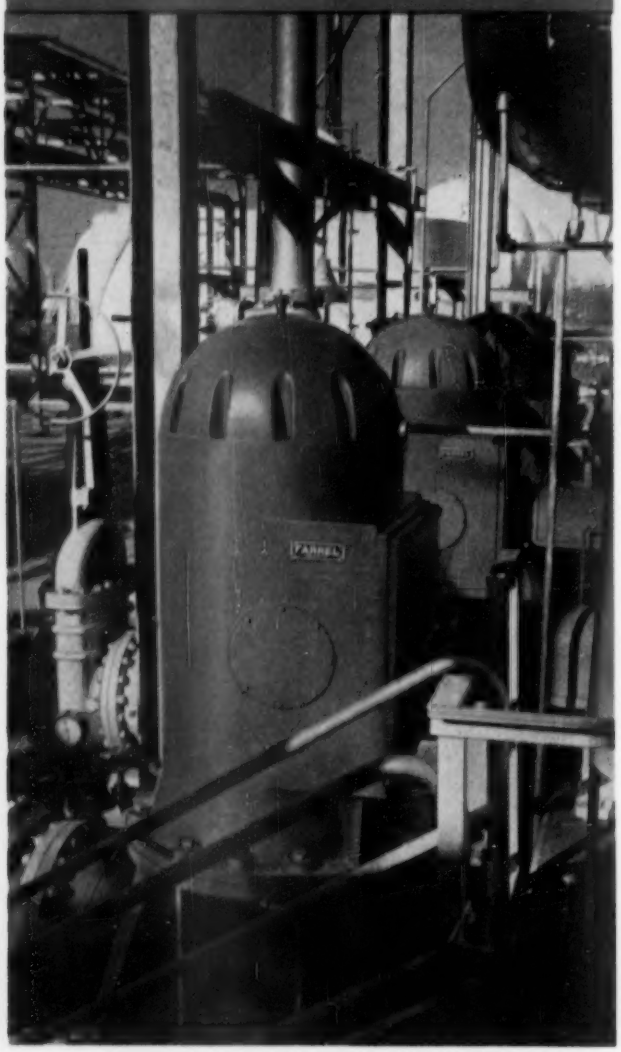
TABLE 3—ESTIMATED RECOVERABLE GAS RESERVES IN TEXAS BY COUNTIES AND DISTRICTS

(Billions of cubic feet—14.65 psia. at 60° F.)

Railroad Commission—	Dissolved and associated	Nonassociated	Total
District 1:			
Atascosa	47.9	10.6	58.5
Bastrop	0.7	1.1	1.8
Bexar	0.8		0.8
Caldwell	11.1		11.1
Dimmit	Negligible	3.5	3.5
Edwards	Negligible		
Frio	24.4	45.0	69.4
Gonzales	Negligible	1.6	1.6
Guadalupe	9.2	4.0	13.2
LaSalle	4.2	1.3	5.5
Maverick		3.5	3.5
McMullen	18.0	41.6	59.6
Medina	Negligible		
Milan	0.7		0.7
Travis	Negligible		
Uvalde		Negligible	
Val Verde	1.0	144.8	145.8
Williamson	1.3		1.3
Wilson	0.7	Negligible	0.7
Zavala	Negligible	32.9	32.9
Total	120.0	289.9	409.9
District 2:			
Bee	40.8	385.5	426.3
Calhoun	44.0	371.8	415.8
DeWitt	112.4	224.9	337.3
Goliad	42.8	470.3	513.1
Jackson	759.2	546.3	1,305.5
Karnes	14.3	210.6	224.9
Lavaca	1.8	303.7	305.5
Live Oak	1.1	684.8	685.9
Refugio	481.1	1,206.4	1,687.5
Victoria	220.2	1,001.6	1,221.8
Total	1,717.7	5,405.9	7,123.6
District 3:			
Austin	49.2	232.5	281.7
Brazoria	1,755.2	4,996.2	6,751.4
Brazos		9.0	9.0
Burleson	Negligible	0.1	0.1
Chambers	631.4	1,230.6	1,862.0
Colorado	3.5	1,719.3	1,722.8
Fayette	1.1	0.4	1.5
Fort Bend	368.2	378.1	746.3
Galveston	230.6	675.3	905.9
Grimes	Negligible		
Hardin	246.7	341.1	587.8
Harris	1,127.1	1,054.4	2,181.5
Jasper	Negligible	4.7	4.7
Jefferson	169.6	837.4	1,007.0
Lee	Negligible		
Liberty	180.1	275.6	455.7
Madison	Negligible	105.2	105.2
Matagorda	203.2	1,550.5	1,753.7
Montgomery	639.1	494.2	1,133.3
Newton	9.6	34.5	44.1
Orange	56.5	345.7	402.2
Polk	52.1	45.4	97.5
San Jacinto	19.7	80.5	100.2
Trinity		27.8	27.8
Tyler	4.4	87.4	91.8
Walker	0.6		0.6
Waller	2.3	5,879.7	5,882.0
Washington	3.2	14.1	17.3
Wharton	193.7	972.5	1,166.2
Total	5,947.1	21,392.2	27,339.3
District 4:			
Aransas	29.9	624.2	654.1
Brooks	73.2	3,523.8	3,597.0
Cameron		27.0	27.0
Duval	239.9	1,056.1	1,296.0
Hidalgo	26.4	3,740.2	3,776.6
Jim Hogg	16.3	100.8	117.1
Jim Wells	284.5	3,069.8	3,354.3
Kenedy	2.4	474.9	477.3
Kleberg	56.6	523.4	580.0
Nueces	379.6	5,232.8	5,612.4
San Patricio	213.4	522.4	735.8
Starr	60.6	692.3	752.9
Webb	44.4	33.6	78.0
Willacy	44.8	159.1	203.9
Zapata	12.1	141.3	153.4
Total	1,484.1	19,921.7	21,405.8
District 5:			
Falls	Negligible		
Freestone	0.7	356.3	357.0
Henderson	13.3	234.3	247.6
Hopkins	31.4		31.4
Hunt	1.5		1.5
Kaufman	2.8		2.8
Leon	8.8	339.3	348.1
Limestone	9.9	86.0	95.9
McLennan	Negligible		
Navarro	19.7	7.4	27.1
Rains		18.6	18.6
Robertson	0.8	2.6	3.4
Van Zandt	153.3	14.8	168.1
Total	242.2	1,059.3	1,301.5
District 6:			
Anderson	133.8	496.8	630.6
Angelina	Negligible	4.6	4.6
Bowie	0.5	Noncommercial	0.5
Camp	3.3		3.3
Cass	89.3	371.6	460.9
Cherokee	4.6	66.8	71.4
Franklin	48.3	1.9	50.2
Gregg	975.4	236.9	1,212.3
Harrison	62.1	1,421.7	1,483.8
Houston	11.9	148.0	159.9
Marion	12.2	437.5	449.7
Nacogdoches	Negligible	409.7	409.7
Panola	11.8	6,122.9	6,134.7
Red River	Negligible		
Rusk	12.0	200.5	212.5
San Augustine	Negligible		

4 FARREL® VERTICAL DRIVES

in service at Shell refinery



Four Farrel RAR units at Shell Oil Company's Norco Refinery.

Four Farrel vertical drive units (shown in photo) are used in pumping cooling water at Shell Oil Company's Norco, Louisiana, refinery. Each transmits 485 HP from a steam turbine operating at 3600 RPM to a pump designed for a speed of 825 revolutions.

These Farrel right angle vertical drives have designed-in special protection at vital points: Gear teeth and pinions precision-generated, hardened and lapped; rigid mountings that assure maintenance of factory-set gear alignment; forged steel shafts made oversize to guard against deflection, and mounted in husky bearings.

You'll find that these features keep Farrel units on the job, without the maintenance-demanding infirmities caused by wear. A Farrel engineer will be glad to discuss your requirements with you at any time. No obligation.

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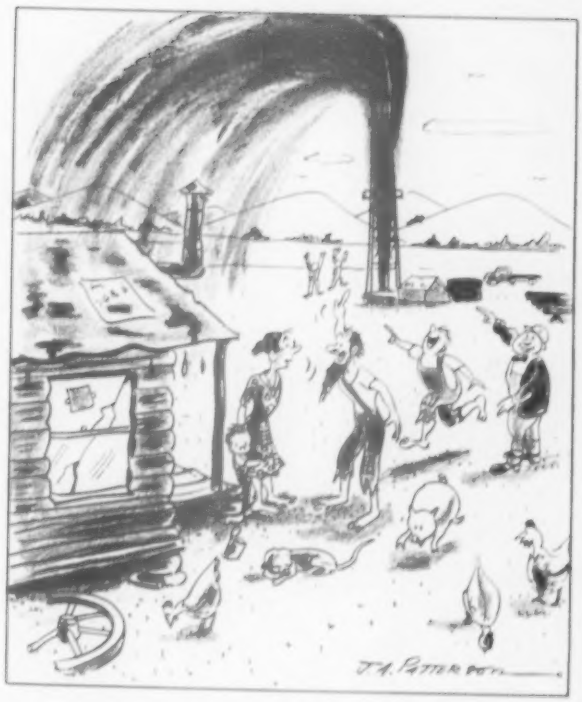
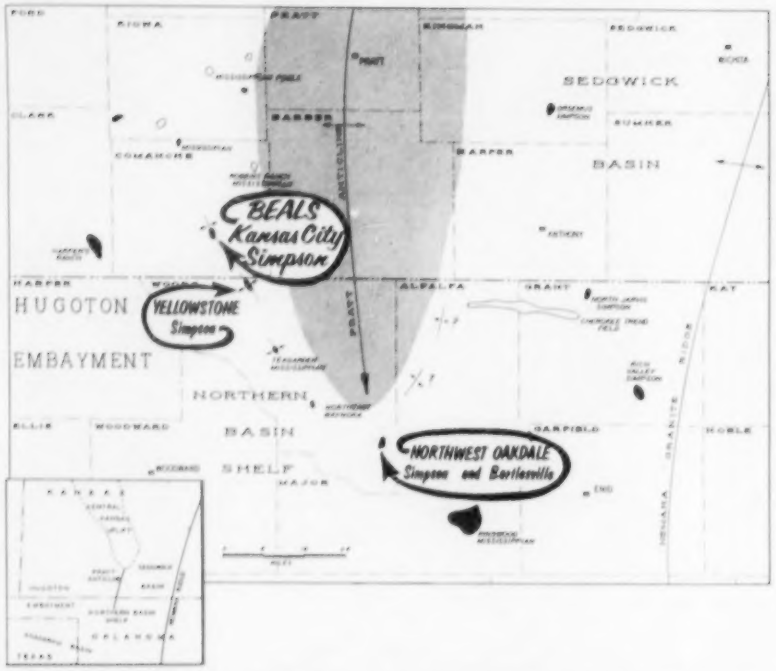
TABLE 3 (Continued)

Railroad Commission—	Dissolved and associated	Nonassociated	Total
Shelby	Negligible	384.2	384.2
Smith	64.3	293.2	357.5
Titus	24.6		24.6
Wood	683.3	167.3	850.6
Total	2,137.4	10,763.6	12,901.0
District 7-B:			
Brown	4.4	22.5	26.9
Callahan	19.8	7.3	27.1
Coleman	44.6	58.7	103.3
Comanche	6.4	7.6	14.0
Eastland	28.9	29.4	58.3
Erath	Negligible	12.6	12.6
Fisher	32.6	0.3	32.9
Hamilton		19.1	19.1
Haskell	25.8		25.8
Jones	58.4	0.1	58.5
Nolan	42.2	0.1	42.3
Palo Pinto	2.8	19.2	22.0
Parker	Negligible	2.3	2.3
Shackelford	44.9	14.3	59.2
Stephens	61.2	96.0	157.2
Stonewall	50.2		50.2
Taylor	10.3	0.5	10.8
Throckmorton	38.4	0.3	38.7
Total	470.9	290.3	761.2
District 7-C:			
Coke	131.2	3.6	134.8
Concho	Negligible	2.7	2.7
Crockett	181.4	231.8	413.2
Irion	1.3	3.2	4.5
Kimble	Negligible	Negligible	
McCulloch	Negligible	Negligible	
Menard	Negligible	0.3	0.3
Reagan	433.5	42.0	475.5
Runnels	87.3	3.4	90.7
Schleicher	31.2	14.7	45.9
Sutton	Negligible	186.1	186.1
Terrell		10.0	10.0
Tom Green	23.2	4.3	27.5
Upton	840.7	143.5	984.2
Total	1,729.8	645.6	2,375.4
District 8:			
Andrews	1,253.9	115.5	1,369.4
Borden	123.5		123.5
Cochran	587.4	1.9	589.3
Cottle	Negligible		
Crane	596.3	31.2	627.5
Crosby	Negligible		
Culbertson	Negligible	6.4	6.4
Dawson	21.9		21.9
Dickens	Negligible		
Ector	2,140.6		2,140.6
Gaines	453.9	128.3	582.2
Garza	76.2		76.2
Glasscock	305.7		305.7
Hale	2.0		2.0
Hockley	456.9		456.9
Howard	306.2		306.2
Kent	275.1		275.1
King	18.8	3.5	22.3
Lamb	34.8		34.8
Loving	16.1		16.1
Lubbock	0.7		0.7
Lynn	0.3		0.3
Martin	2.4		2.4
Midland	541.7		541.7
Mitchell	14.1		14.1
Pecos	209.4	228.5	437.9
Reeves	17.6	2.2	19.8
Scurry	1,848.2		1,848.2
Sterling	1.1		1.1
Terry	83.2		83.2
Ward	99.3	54.3	153.6
Winkler	944.5	229.9	1,174.4
Yoakum	1,181.0		1,181.0
Total	11,612.8	801.7	12,414.5
District 9:			
Archer	149.9		149.9
Baylor	5.5		5.5
Clay	86.3		86.3
Cooke	121.4		121.4
Denton	3.4		3.4
Foard	4.0	2.0	6.0
Grayson	183.3	16.8	200.1
Hardeman	Negligible		
Jack	69.2	7.3	76.5
Knox	18.3		18.3
Montague	126.1	0.4	126.5
Wichita	156.2	0.7	156.9
Wilbarger	41.2		41.2
Wise	22.1	896.4	918.5
Young	85.2	8.7	93.9
Total	1,072.1	932.3	2,004.4
District 10:			
Carson	63.5	1,989.0	2,052.5
Collingsworth	Negligible	167.0	167.0
Dallam		46.0	46.0
Gray	302.4	1,859.3	2,161.7
Hansford	4.0	1,685.0	1,689.0
Hartley	Negligible	264.0	264.0
Hemphill	Negligible		
Hutchinson	317.4	1,991.0	2,308.4
Lipscomb			
Moore	16.6	4,113.8	4,130.4
Ochiltree	22.3	154.6	176.9
Oldham		19.0	19.0
Potter	Negligible	1,227.0	1,227.0
Roberts	58.8	201.4	260.2
Sherman	1.0	4,179.2	4,180.2
Wheeler	132.2	1,338.8	1,471.0
Total	918.2	19,235.1	20,153.3



"Now can I have that new stove handle, Paw?"



Recent Ordovician discoveries on the flanks of the Pratt anticline in southwestern Kansas and northwestern Oklahoma put new emphasis on the regional importance of shelf rocks in the future oil reserve picture of the area.

Five areas in widely separated sectors of the northwest and western Anadarko basin have production from Ordovician and Cambro-Ordovician rocks . . . Grigsby and Beals fields in Kansas; Yellowstone and Northwest Oakdale in Oklahoma, and Laketon-Delp (Ellenburger) field in Texas.

by John C. McCaslin

An Ordovician discovery in Southwest Kansas opens

New Exploratory Era on Northern Shelf

PURE OIL CO. opened first Simpson sand production in southwestern Kansas at its 1 Parks in Comanche County, heralding a new era for exploration for the Kansas portion of the northern shelf of the Anadarko basin.

The discovery well, a confirmation and new-pay strike for Beals field, gaged 8,980 M.c.f. of gas per day with distillate on drill-stem test of the Simpson at 5,656-66 ft. The well also flowed 6,200 M.c.f. of gas daily from the Kansas City-Pennsylvanian and about 1,000 M.c.f. from the Mississippian. Beals field was opened last year by Pure for 3,800 M.c.f. of gas per day from the Kansas City-Lansing lime. The strike opened first deep production in Comanche County.

Another link . . . The Beals field discovery is another link to the growing chain of deep reservoirs around the southwestern flanks of the Pratt anticline, a southward-plunging structure that juts off the Central Kansas uplift onto the northern shelf of the Anadarko basin.

The Simpson strike at Beals field is the second in recent months in this region. Late last year Amerada Petroleum Corp. established important Simpson production in Woods County, southeast of Beals field in Oklahoma. The 1 Farris flowed 285 bbl. of oil per day from the Simpson sand at 7,450-56 ft., causing considerable excitement in oil circles. Nearest previous Ordovician production was in Yellowstone field, another Simpson reservoir 30 miles northwest. Further significance was added to the Farris discovery (Northwest Oakdale field) late in March. Amerada added a new pay sand to the pool at 1 Morgan. This discovery flowed 4,378 M.c.f. of gas per day from the Bartlesville-basal Pennsylvanian sand at 6,102-22 ft., moving Bartlesville production to its westernmost point in Oklahoma.

The opening of Yellowstone field in 1953 was a potent force in drawing new attention to the potentialities of the Ordovician rocks on the northern shelf of the Anadarko basin. Previous Simpson discoveries in Grant and Garfield counties, Oklahoma, had emphasized the regional importance of shelf rocks in the future oil-reserve picture of the region. The recent Ordovician, Mississippian, and Pennsylvanian strikes in the area drive home this importance.

In a growing chain . . . In the past 3 years an impressive list of new fields has popped up along the flanks of the Pratt anticline.

The north end of the chain is the new Mississippian gas-condensate reservoir in Kiowa County, one of the most highly regarded new Kansas producing areas in recent years. Farther south, Robbins Ranch field in northeastern Comanche County was the county's sole producer until Beals field was opened. Across the state line is Yellowstone field in Woods County, Oklahoma, which at the time of its discovery 3 years ago was the first Ordovician production in the entire northwestern Anadarko basin region.

Later, Arbuckle-Cambro-Ordovician production was opened in Scott County at the far north end of the Hugoton embayment in Kansas. That oil strike, despite its small potential, moved Arbuckle production across four Kansas counties into a whole new realm of pre-Permian hope.

In 1955, first Ellenburger production

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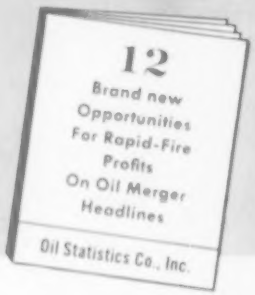
from new oil industry mergers



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Merger stock LION OIL CO.	up 27%	in 1 month
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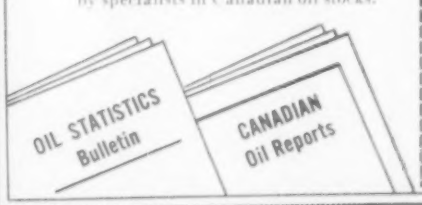

Mergers are spreading through the oil industry like wildfire. Investors keen enough to spot merger stocks early have earned 29% in PROFITS in less than *2 months' time!*

Because biggest merger profits come *ahead of the news*, Oil Statistics' Staff of oil security specialists have researched 100 oil companies to find out IN ADVANCE the best prospects for mergers . . . and found 12 companies which turned out to be *topflight candidates for future mergers* (7 are already rumored to have been bid for by "majors") . . . stocks like these:

A Second Kirby Oil—Up 30% . . . One of the 12 new "buy-out" oils in our Merger Report certainly looks like it. In fact, a merger headline *could shoot this stock up 55%* because of its amazingly high crude oil asset value. And the merger tide *runs especially strong here* because the company, as you'll learn, is already more than *half-owned* by one of America's leading oil outfits!

Another 35%-Climber like Warren . . . *Definitely yes*, we believe, as far as this second oil goes. Actually, in the event of a merger, this splendid issue could be worth *a rock bottom price of $82 . . . 60% over today's unrealistically low* market value. And, merger or no, we believe this stock is bound to advance sharply in 1956. But, if merger talk begins *AGAIN*, it could really zoom to bring you *sudden riches*.

A King-Size 80%-Plus Upsurge Potential is latent in still another of these 12 merger candidates, if this company becomes involved in "buy-out" negotiations. And, the *tiny common stock issue* plus *the extraordinarily large* stock asset value make this *terrifically undervalued* concern a *prime "buy-out" target*. Already rated a *"safe* buy for Major 1956 gains," merger rumors could turn this oil issue into *one of your largest profit-headliners*.

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The oil industry's newest trend to expansion by merger can bring *sudden wealth* to investors keen enough to spot mergers in advance. Important factors point to 1956 being the biggest merger year yet. They are:

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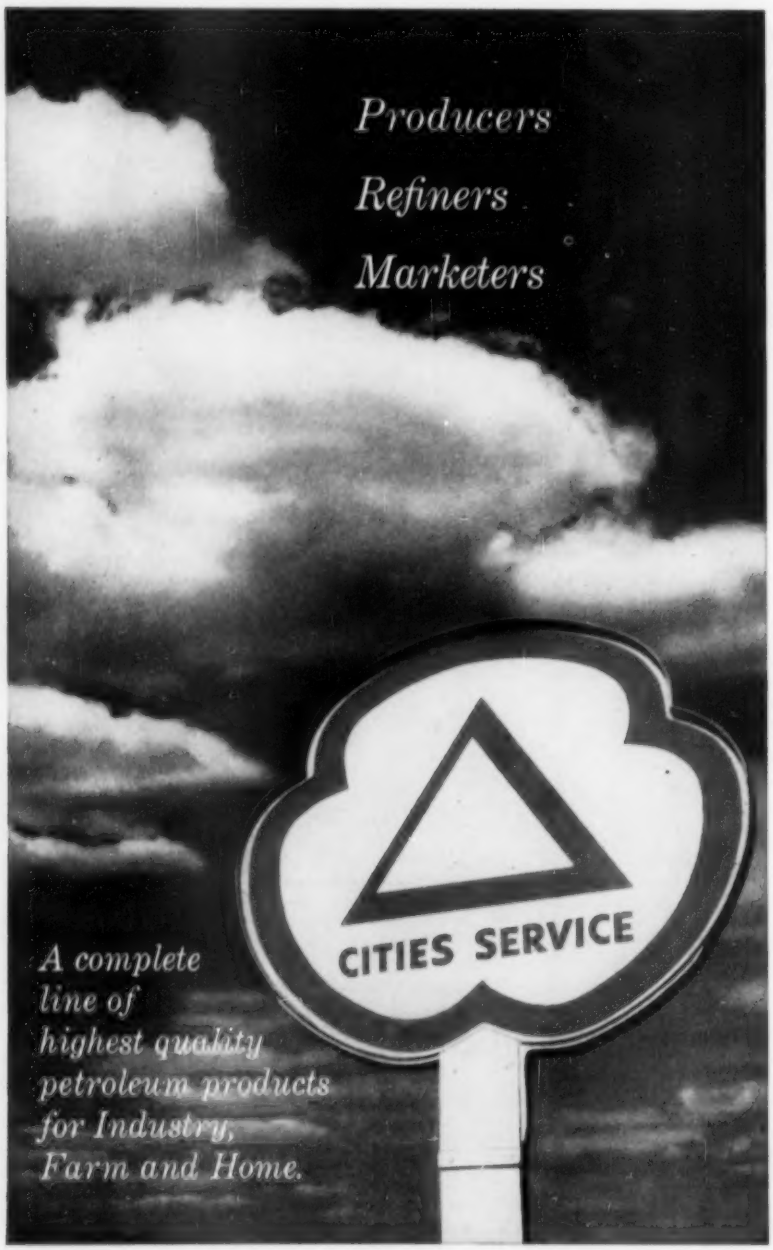
in the Texas Panhandle startled the industry, further emphasizing the growing importance of deep exploration throughout the western reaches of the Anadarko basin.

After the Yellowstone field discovery in Oklahoma two other fields were opened in Woods County (Teagarden and Northeast Waynoka, Mississippian and Layton-Pennsylvanian producers, respectively).

Begins new era . . . Despite its long oil-producing history, new avenues for Oklahoma oil explorers are being opened.

The resounding success of exploration in the Oklahoma Panhandle in the past 3 years has barely dented the region's potentialities. The lonesome counties in the central basin flank area of the Anadarko region lie hopefully in wait for the wildcat drill. The green light for exploration on the northeastern shelf burns brightly. There may be those who say the Mid-Continent is past its peak on the wildcat trail. But this is merely a fairy tale. Look for a real exploratory spree across the reaches of the Anadarko basin in the coming months. The favorable conditions are there, the new fields are there for confirmation, and the rank wildcat frontiers of the region are there to be crumbled.



The Regional Picture

The northern shelf is one of five subdivisions of the Anadarko basin, one of the biggest, most attractive, and unproven basins in the country.

The five divisions of the basin are: the trough area, southeastern embayment, central basin flank, northern shelf, and the Hugoton embayment.

. . . The trough. The deep trough of the basin runs southeastward from the Texas Panhandle (north of the Amarillo-Wichita uplift) to the Pauls Valley-Arbuckle uplift in Oklahoma. The structures down in this depression are highly faulted, with several hundred feet of closure and steep flanks.

. . . Southeastern embayment. This is the highly productive section of the Anadarko basin. It is located at the extreme southeastern corner, primarily in the Bradley district of Grady County. Intersecting faults with both structural and stratigraphic traps make this area highly lucrative to the oil hunters.

. . . Central basin flank. The most mysterious and unknown portion of the Anadarko basin is the central flank which lies north of the trough and south of the northern shelf.

The area involved covers an immense area of western Oklahoma. Sediments are thick, oil objectives are at great depths, and few wells have probed into the unknown.

. . . Hugoton embayment. This portion of the basin occupies the Oklahoma and Texas panhandles, portions of northeastern New Mexico and southeastern Colorado, and southwestern Kansas. The thick Pennsylvanian sediments in the embayment are the current objectives of the drill. Pre-Premian exploration in this province began about 3 years ago in earnest. The results have been gratifying. A whole new outlook for the future of this petroliferous province resulted from deep discoveries in an area where only Permian gas production was previously known.

There is little hope for much Ordovician success in the embayment. The Ordovocian section is thin, grading westward into a facies of little porosity.

. . . Northern shelf. The northern shelf of the Anadarko basin is a relatively new interest center in the region. The first real inkling of the area's potential came with the opening of North Jarvis-Simpson pool in Grant County 3 years back and the Yellowstone pool strike. The subsequent strikes at Oakdale and Beals put real fire into the search for Ordovician production on the shelf area. In spite of rapid variances in sand thicknesses and porosity,

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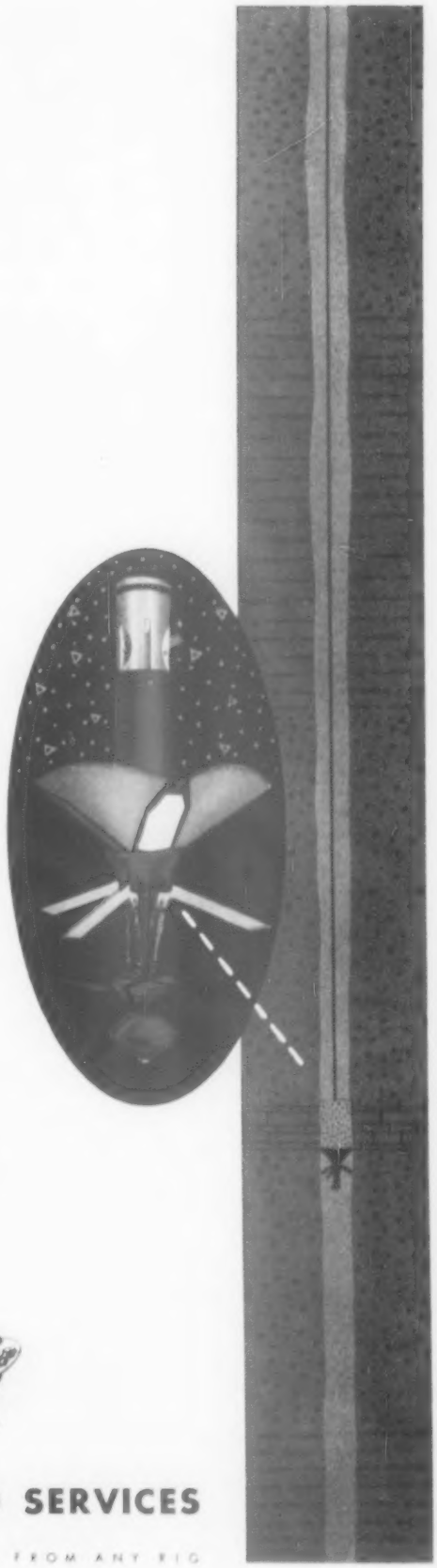

One of the most useful tools ever invented for doing remedial work on oil wells is the "DB" Bridging Basket used in Halliburton's Dump Bailer Service.

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the Simpson sands are highly promising reservoir possibilities on the shelf, especially in areas of Ordovician folding. The Mississippian and Pennsylvanian successes on the flanks of the Pratt anticline and on the shelf are not to be weighed lightly.

The flank discoveries off the Pratt anticline and on the northern shelf add powder to the Knebel doctrine that 70 per cent of our oil has been found on the stable sides of basins. The northeastern shelf of the Anadarko basin thus holds great hope for major fields. The big fields of the basin to date have opened on the mobile southern and western edges.

EXPLORATION HIGHLIGHTS

WEST TEXAS-NEW MEXICO

WEST TEXAS

Gaines County Gets Two Discoveries

Northern Gaines County had two discoveries completed, both wells being in the Pennsylvanian Strawn.

Husky Oil Co., Anderson-Prichard Oil Co. and U. S. Smelting, Mining & Refining Co. 2 Webb added Strawn pay to the Seagraves-Devonian field. Potential was 324 bbl. of oil a day from pay at 11,450-475 ft.

Husky Oil Co. has opened a new Strawn pool northwest of Seminole, and participated in the discovery of Strawn oil in the Seagraves-Devonian field, Gaines County.

No. 2 Webb was previously completed as a Devonian well, at 13,034-46 ft.

Husky 1 Wimberly, new strike between Russell and Seminole fields, Gaines County, has been completed for a daily potential of 407.5 bbl. a day. Production was through ¾-in. choke, from perforations at 10,240-250 ft. Top of the Strawn was 10,238 ft. on elevation of 3,859 ft. Husky owns 100 per cent working interest in the discovery, and holds 840 acres in the area of the well.

Permian New Pay Opener Makes High Potential

Kewanee Oil Co. 1-P University, in 5-30-University Survey, has added San Andres production to the Dune-Grayburg field in eastern Crane County.

Daily potential was 602.6 bbl. of 33° oil, based on a 5-hour gage of 125.58 bbl. through ¾-in. choke. Pay was perforated at intervals between 3,408-3,648 ft. and fractured with 10,000 gal. Dune, Southeast field, 2¼

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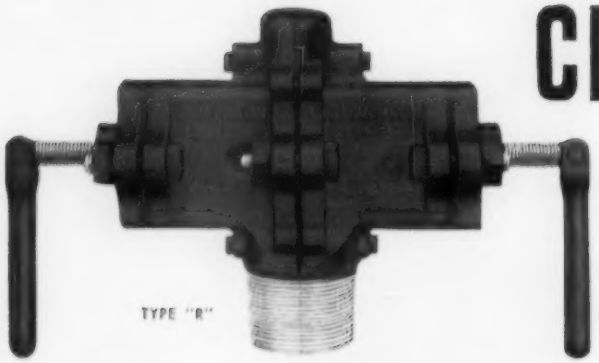

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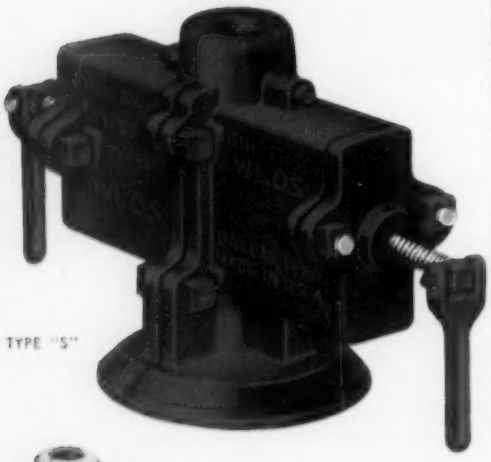

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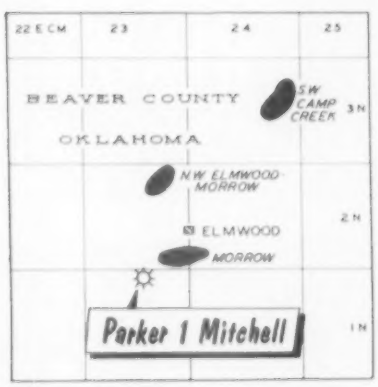
HUGOTON EMBAYMENT

OKLAHOMA PANHANDLE

New Morrow Gas Strike Recorded in Busy Beaver

The Morrow campaign in Beaver County rolls on with a new gas-distillate producer reported at Parker Petroleum 1 Mitchell, C SE SW 3-1n-23eCM, 2 miles southwest of a recent new oil and gas field discovery made by Orville Parker in the South Elmwood area.

The well flowed 9,000 M.c.f. of gas per day with a distillate spray at 7,631-69 ft. This discovery opens the third Morrow area in the Elmwood area in recent months.



Parker Petroleum Co. opened Morrow gas production at 1 Mitchell in C SE SW 3-1n-23eCM, Beaver County.

Inside Hugoton Well Flows Gas From Morrow Sand

Panhandle Eastern Pipeline Co. 2-24 Ballew, C SW NE 24-3n-17eCM, Texas County, flowed 1,632 M.c.f. of gas in 10 minutes on drill-stem test of the Morrow sand at 6,252-6,325 ft., increasing to 3,400 M.c.f. in 20 minutes.

This well is a deep test inside Permian production area of Hugoton gas field.

TEXAS PANHANDLE

Morrow Discovery Finaled Northeast of Farnsworth Field

A new Morrow gas pool was opened 5 miles southwest of Perryton in north-central Ochiltree County. The discovery well is Superior Oil Co. 1 C. H. Oringderff, 8 miles northeast of Farnsworth field.

The well flowed 7,300 M.c.f. of gas per day on absolute open flow potential plus 40 bbl. of distillate per day on 22/64-in. choke. Perforations were at 7,919-25 ft. The distillate was 71° gravity.

SOUTHEAST COLORADO

Kiowa County Well Reworked for Morrow Gas

A 1952 gas discovery in Kiowa County was reworked by Continental Oil Co. to have an open flow of 2,705 M.c.f. per day from the Morrow sand.

The well was originally completed for only 357 M.c.f. per day. The well is the 1 McClave, SE SE SE 11-20s-49w. The well had been shut in since its discovery. Its location ¾ mile from the Colorado Interstate Gas Co. gas line from Hugoton field places new interest on the possibilities of this Las Animas arch region of southeastern Colorado.

The well flowed 1,733 M.c.f. per day on 1½-in. choke, tubing pressure 22 psi.; 1,600 M.c.f. per day on 1½-in. choke, tubing pressure 35 psi.; 1,304 M.c.f. per day on 1-in. choke, tubing pressure 50 psi.; and 1,237 M.c.f. per day on ¾-in. choke, tubing pressure 98 psi. Shut-in bottom-hole pressure was 973 psi.

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ROCKY MOUNTAIN

NORTH DAKOTA

Madison Discovery Finaled Between Capa and Hofflund

The area between Capa and Hofflund fields in Williams County has a new Madison pool. Amerada Petroleum Corp. finaled the 1 Kahlert, SE NW 7-154n-95w, for 117 bbl. of oil and 50 bbl. of water in 16 hours. Perforations were at 8,446-66 ft., gravity of the oil being 43.8°. The flow was through 16/64-in. choke.

MONTANA

Extension Well at Wolf Springs Completed

DeKalb Northern Oil Division finished the 1 State in C SE NE 24-7n-31e, Wolf Springs field, Yellowstone County, for an initial flow of 785 bbl. of oil daily on ¾-in. choke.

The big extension discovery is a southwest extension in the field. It is ¾ mile from other producing wells. The well flowed from Amsden dolomite at 6,196-6,226 ft.

APPALACHIAN

EASTERN KENTUCKY

In the Right Fork sector of Martha pool of Lawrence and Johnson counties —Ashland Oil & Refining Co. have completed 15 R. N. Sparks as a 10 bbl. per day Weir (Mississippian) sand producer. Test was bottomed at 856 ft.

Columbian Carbon Co. has completed a successful well after Sandfracing 1 Benton Smith, an old well drilled deeper in the Pike County sector of Big Sandy gas field. Pay is the Mississippian Maxon sand from 1,747 to 1,762 ft. The well tested for only a small amount of gas natural but after Fracing, initial open flow was 1,107,000 cu. ft. of gas daily. Total depth was logged at 1,788 ft. This is thought to be the first Maxon well to be Fraced in Big Sandy field.

OHIO

A number of rigs have moved into the area of the old Berea sand pool in Killbuck Township, Holmes County, and fairly good wells have been found in the deeper Clinton sand. Pure Oil 1 (6) G. P. Lepley, Section 11, gaged 50 bbl. and an estimated 400,000 cu. ft. gas from fractured sand at 3,139-98 ft.

- The pool in western Perry Township, Coshocton County, was extended

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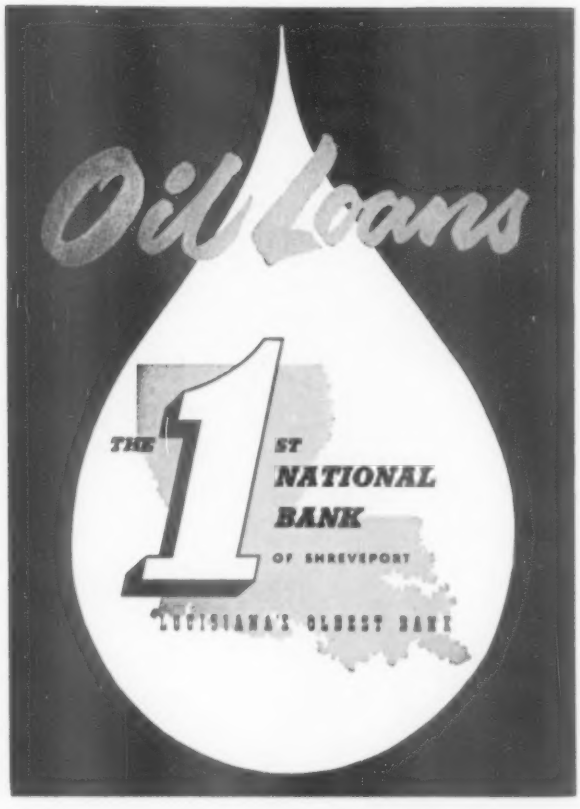

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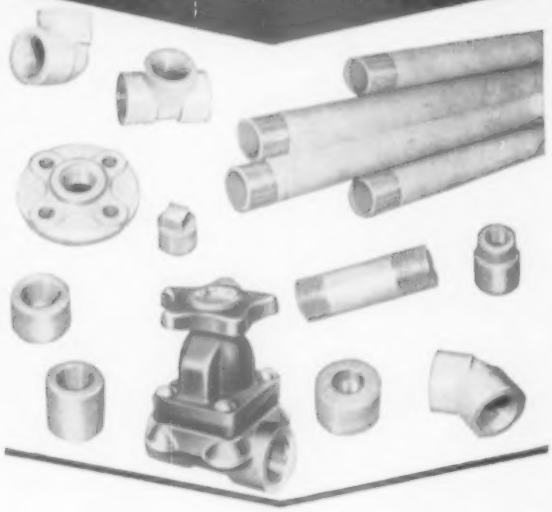

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nearly ½ mile to the southeast by the George Sheaf & Co. 5 A. E. Crowthers, Sction 18. Clinton at 3,023-67 ft. gaged 95 bbl. after fracture.

● A new pool in Hopewell Township, Perry County, is confirmed by a second well, the C. M. Foraker et al., 1 Wayne Kelly, Section 9. Clinton at 2,789-2,819 ft. gaged 250 bbl. after treatment.

PENNSYLVANIA

In Armstrong Township, Indiana County, Southwest Pennsylvania, Columbian Carbon Co., is moving in on a rank wildcat location at 1833 Susie Yosurack, Indiana Quadrangle. It is west of the town of Indiana, 2.93 miles south of latitude 39 degrees 40 minutes and 4.35 miles west of longitude 79 degrees 10 minutes.

WEST VIRGINIA

Plymouth district, Mercer County, West Virginia, United Fuel Gas Co., has located No. 8425 Sally L. Bailey, elevation 2,472 ft., Bluefield Quadrangle, 1.15 miles south of latitude 37 degrees 25 minutes and 2.48 miles west of longitude 81 degrees 00 minutes.

● Allen district, Morgan County, John Fox, is moving back in at 1-K-1 Amasa Nestor. The hole was shut down at 3,260 ft., with a hole full of water and the tools were moved out for the winter.

WESTERN CANADA

ALBERTA

Keystone Area Has Alberta Indicated Cardium Strikes

A Canada Cities Service Petroleum Corp. operated venture in the Keystone area of central Alberta appears to have good chances of commercial oil production from the Cardium sand as a result of a drill-stem test conducted in that formation at the well recently. The well lies 45 miles west-southwest of Edmonton city limits and is 14 miles east of the closest oil production in the huge Pembina, Cardium zone, oil field area. After testing the Cardium formation, which gave up 310 ft. of heavily oil and gas-cut mud, crew resumed drilling operations.

This strike, Canada Cities Service 8-15 Keystone, LSD 8, 15-48-4w5, is on wholly owned acreage that was purchased from the Alberta Government under the form of a drilling reservation.

Only drill-stem test reported was of the interval 4,273 to 4,306 ft. Pipe recovery, after the valve was open 75 minutes, consisted of the oil-cut mud and 90 ft. of oil slightly gas cut.

Viking Show Reported At Sundre Area Well

Hudson's Bay Oil & Gas Co., Ltd., found an encouraging oil show in the Viking sand at a field well in Sundre, the Mississipipan zone oil-producing area of southern Alberta, during a recent drill-stem test. The well is ⅝ mile southeast of the 15-27 Sundre oil producer in the southeast corner of that field.

This test, Hudson's Bay 9-27 Sundre, LSD 9, 27-33-5w5, yielded a 1,615-ft. oil recovery on drill-stem test in the Viking sand at 7,980-8,080 ft. Crew has resumed drilling operations and will take the well down and complete in the Mississippian.

Gas Discovery Reported At Hardisty Wildcat

New Gas Exploration of Alberta currently drilling a wildcat venture on Pacific Petroleum Limited acreage in the Hardisty area of central Alberta has discovered gas in the basal Cretaceous formation at that venture. The well, New Gas Exploration-Pacific I Hardisty, on LSD 13, 22-42-104w, flowed gas to the surface at a maximum rate of 2,295,000 cu. ft. daily, during drill-stem test operations.

This I Hardisty success lies 5 miles south of Hardisty town and is 2 miles southeast of the Pacific I Hardisty exploratory dry hole. Discovery drill-stem test was run of the interval 2,747 to 2,760 ft. The maximum rate of 2,295,000 cu. ft. decreased to 1,805,000 cu. ft. daily by end of test. There was no pipe recovery.

SASKATCHEWAN

Details Released on Two Mississippian Hits

Imperial Oil, Ltd., released details on two of its most recent oil discoveries in southeastern Saskatchewan. One of the wells, the 7-19 Rockland, 3½ miles northeast of Steelman field, registered success in the Mission Canyon zone, while the other, the 5-8 Alameda, 7 miles southeast of Rockland field, yielded prospects of oil in both the Charles and Mission Canyon zones of the Mississippian.

The Rockland strike is on LSD 7, 19-4-4w2. It recovered up to 1,350 ft. of clean oil on 12 drill-stem tests over a 86-ft. interval around the 4,500-ft. mark in the Mission Canyon. The Alameda well, LSD 5, 8-4-3w2, made only recoveries of oil-cut mud, gassy oil-cut mud and salt water on drill-stem tests in both zones. Production casing has been set to total depth of 4,600 ft. to carry out production tests.

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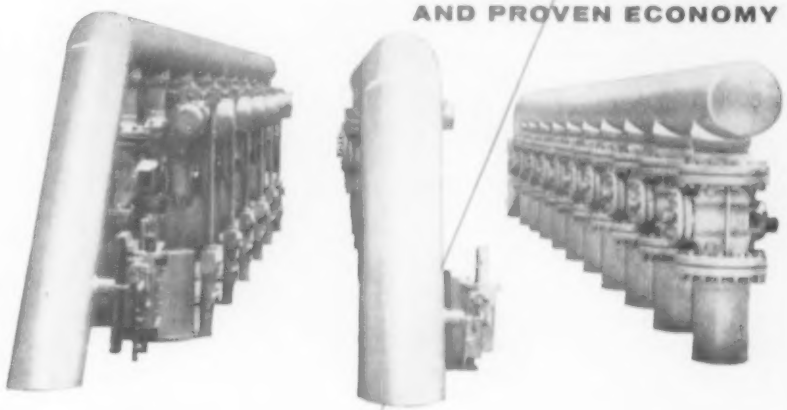

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KANSAS

Barber County: Carl Todd 1 Smith, NE NW SE 9-31s-11w. IP 5,216 M.c.f. of gas per day, Simpson. TD 4,940 ft. (Opens Ills pool).

Butler County: C. L. Carlock 1 Wehrman, SW SW NE 17-29s-8e. IP 25 BOPD, Mississippi. TD 2,715 ft. (Opens Northeast Shinn pool.)

Chautauqua County: Continental Oil Co. 1 Rich, NE NE NE 16-33s-9e. Completing in Mississippian. TD 2,620 ft. (Opens Rich pool.)

Cowley County: Ayesh Oil Co. 1 Kraft-Kelso, SE SE NW 33-31s-7e. Completing in Layton with total depth 2,062 ft. (Opens Cambridge pool.)

Bob Jones 1 Collinson, NE NE SW 21-33s-4e. IP 30 BOPD, Mississippi. TD 3,178 ft. (Opens Posey pool.)

Ellis County: Continental Oil Co. 1 Boos, NW SE SW 20-15s-17w. IP 117 BOPD, Arbuckle. TD 3,537 ft. (Opens Boos pool.)

Frontier Oil Co. 1 Lieb, NE NW SW 17-11s-16w. IP 83 BOPD, Arbuckle. TD 3,363 ft. (Opens Lieb pool.)

Harper County: J. M. Huber 1 Denton-Fox, C SW NE 30-34s-6w. Completing in Simpson. TD 5,239 ft. (Opens Wildcat Creek pool.)

Logan County: Oakley pool, NW SE SW 3-11s-32w. Completing in Marmaton. TD 4,750 ft. Opens first production in county.

Morris County: Kuper et al 1 Teel, NW NW NW 24-16s-9e. Completing in Viola. TD 3,041 ft. (Opens Northeast Comiskey pool.)

Pawnee County: A. F. Brann 1 Bahl, SE SE SE 5-22s-16w. Completing in Arbuckle. TD 3,907 ft. (Opens Southwest Larned pool.)

GMR Oil Co. 1 Boyd, NW NW NE 12-22s-16w. Completing in Arbuckle. TD 3,927 ft. (Opens South Evers pool.)

Rooks County: Kaiser-Francis 1 Trarback, NW SW NW 36-10s-20w. Completing in Arbuckle. TD 3,685 ft. (Opens Trarbach pool.)

Stafford County: Welch & Olsson 1 Leiss, SW SW NE 23-25s-13w. IP 54 BOPD, Simpson. TD 4,305 ft. (Opens Leiss pool.)

Petroleum, Inc. 1 Henderson, NW NW SE 7-24s-13w. IP 1,393 BOPD, Lansing. TD 4,175 ft. (Opens East Rattlesnake pool.)

Trego County: Imperial Oil of Kansas 1 Newcomber, NE NE SW 12-12s-23w. Complete for bomb test of 3,000 BOPD, Lansing. TD 4,130 ft. (Opens Newcomber pool.)

SOUTH LOUISIANA

Plaquemines Parish: Humble Oil & Refining Co. 1-A State Lease 2789, Tract 20, South Pass Area, Gulf of Mexico. Shut-in gas well, no gage, perforations 9,521-34 ft. TD 14,006 ft. (New offshore field.)

Terrebonne Parish: Shell Oil Co. 6 Peters, 71-18s-18e. IP 28 BCPD and 1,775 M.c.f. daily, 5/32-in., 63.2°, perforations 9,773-84 ft. TD 15,000 ft. (New pay in South Houma field.)

OKLAHOMA

Beaver County: Cabot Carbon Co. 2 Barby "B," SW SE NW 27-4n-25eCM. IP 18,000 M.c.f. of gas per day, Morrow sand. TD 7,179 ft. (Gas discovery in Hugoton embayment).

Harper County: Magnolia Petroleum Co. 1 Stinson, 3 miles north of production in C NE SW 12-26n-25w. IPF 204 BDPD, 22,500 M.c.f. of gas per day, Tonkawa 5,540-58 ft., 67.8°, open flow. IPF 152 BDPD Morrow sand, 12,300 M.c.f. of gas per day, 6,968-86 ft., 65.3°. TD 7,540 ft. (Dual gas-distillate discovery in northwestern Anadarko basin).

EAST TEXAS

Titus County: John B. Stephens and R. L. Peveto 1 Fla Lewis et al., M. V. Delgado Sur., A-159, 4 miles NE Talco, 1½ miles N Talco field. IP 230 BOPD, 14/64-in., no water, TP 260 psi., GOR 207, 33°, Paluxy perforations 4,702-14 ft.; IP 3,600 M.c.f. gas, plus 99.3 bbl. 61° condensate per 1,000 M.c.f., ¾-in., CP 2,710 psi., GLR 10,495:1, Rodessa perforations 6,449-54 ft. TD 6,828 ft., elev. 307 ft. Dual discovery. New field name, Christmas Bay.

WEST TEXAS

Concho County: Union Producing Co. 1 Campbell, R. Roho Sur. 1617, 2 miles W Mereta. IPP 86 BOPD, 38°, GOR 739, Strawn lime 4,008-15 ft. TD 5,850 ft., elev. 1,714 ft.

Gaines County: Shell Oil Co. 1-A Williamson, 110-14-D&W Sur., 15 miles NE Seminole. IP 192 BOPD, 7/64-in., TP 550 psi., 33.7°, GOR 32, top Devonian 13,068 ft., elev. 3,227 ft., perforated 12,995-13,076 ft. TD 13,076 ft. Devonian pay discovery in Felmac field.

Upton County: Salsich, McGrath & Smith 1 Owens, 91-Y-GC&SF, 7 miles SE Crane. IPP 130 BOPD, 31°, GOR zero, Grayburg 2,521-2,625 ft. TD 2,625 ft.

WEST CENTRAL TEXAS

Callahan County: Gly Inc. 1 Hart, Sec. 61, EAL Sur., 10 miles NE Baird. IP 800

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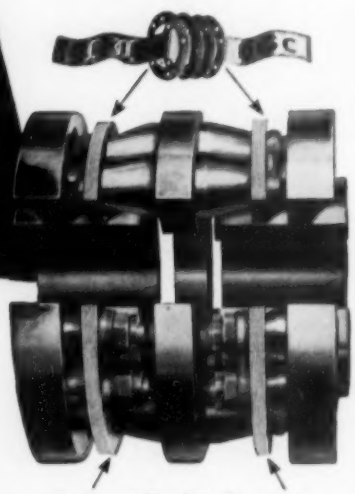

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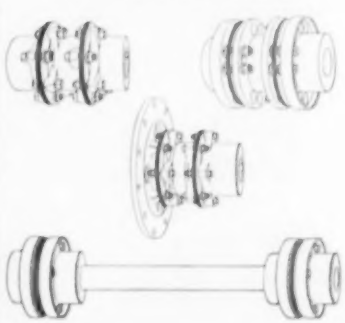

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BOPD 32/64-in., TP 140 psi., GOR 430, 44°, Palo Pinto sand 2,068-80 ft.

Coleman County: H. A. Birdwell & Son Drilling Co. 1 Horne, S. Robinson Sur. 154, 1 mile W Coleman. IP 239 BOPD, ¾-in., TP 80 psi., GOR 375, 41.5°, Gardner sand 2,644-51 ft. TD 2,651 ft.

Haskell County: Amarillo Oil Co. 1 Handrick, Wise CSL Sur. 76, 2½ miles SW Rochester. IPP 121 BOPD, 40°, GOR 510, conglomerate 5,772-80 ft. TD 5,831 ft.

G. E. Kadane & Sons 1 Strain, T. D. Owings Sur., A-337, 5 miles SE Haskell. IP 127 BOPD, 32/64-in., TP 60 psi., 40.5°, GOR zero, Canyon reef 3,490-94 ft. TD 3,504 ft. Suggested name, Victoria-Canyon Reef.

Shackelford County: Bridwell Oil Co. 1 Driller estate, Ahrenbeck Sur. 3, 9 miles NNE Albany. IP 27 BOPD, 10/64-in., TP 220 psi., GOR 900, 39°, Lower Tannehill sand 692-698 ft. TD 4,725 ft., PB 805 ft.

Irish Drilling Co. 1 McKeever estate, 14-3-H&TC, 14 miles E Stamford. IPP 90 BOPD, 38°, GOR zero, King sand 1,887-93 ft. TD 1,949 ft.

Stephens County: Bid D Oil Co. 1 Boyd, Sec. 1162, TE&L Sur., 2½ miles NW Crystal Falls. IP 242.6 BOPD, 12/64-in., TP 825 psi., GOR 625, 40°, Marble Falls 4,111-17 ft., TD 4,480 ft. Suggested field name, Cal-Currey (Conglomerate).

NORTH TEXAS

Archer County: Bobby Burns 1 Coleman, Blk. 34, Coleman Subd., Brazos CSL Sur., 2 miles N Scotland. IP 143 BOPD, 20/64-in., TP 100 psi., GOR 44°, conglomerate 5,737-48 ft. TD 6,135 ft.

Jack County: Ted Norwood 1 Sewell, J. B. Irvine Sur., A-312, 10 miles SE Antelope. IPP 75 BO in 12 hours, 37°, GOR 100, pay 2,767 ft. TD 2,769 ft.

Wise County: W. F. Lacy and Revier Drilling Co. 1 Green, H. Tidwell Sur., A-807, 4 miles NW Boonville. No. IP, completed as shut-in gas well. Flow estimated 6,000 M.c.f. gas per day on DST, conglomerate pay 4,445 ft. TD 5,214 ft.

TEXAS GULF COAST

Fort Bend County: Humble Oil & Refining Co. 1 Huntington, Hy Scott Sur., A-83 (2½ miles NW of Rosenberg). IP 26,000 M.c.f. daily, estimated open flow, perforations 4,782-90 ft. TD 9,002 ft. (New field.)

The Texas Co. 1 Sliva, W. T. Lightfoot Sur., A-282, IP 138 BOPD, ⅝-in., 39.8°, perforations 8,135-40 ft. TD 8,700 ft. (New pay in Barb-Mag field.)

Kenedy County: Humble Oil & Refining Co. 13 Armstrong, Barreta Grant. IP 135.36 BOPD, ⅝-in., 55.2°, perforations 7,028-38 ft. TD 9,500 ft. (New pay in Candelaria field.)

Newton County: Christensen & Matthews 1-A Morgan et al., J. A. Mason Sur. 12, A-324. IP 26,000 M.c.f. daily, GLR 36.85 M.c.f. per bbl., 52.5°, perforations 7,599-7,601 ft. TD 7,672 ft. (Extension and new pay Northwest Hartburg area.)

Kilroy Co. of Texas 2 Quinn, W. F. Sheppard-H&TC Sur. 26, A-1189. IP 137.45 BOPD, 9/64-in., 36.2°, perforations 8,729-32 ft., and (dual completion) 17,500 M.c.f. daily, open flow, GLR 25.7 M.c.f. per bbl., 59°, perforations 8,486-90 ft. TD 8,950 ft. (Two new pays in Dolly area.)

Nueces County: Continental Oil Co. 1 Bauer, Lot 4, Tract 2, George H. R. Paul Farm Tracts, Mariano Lopez de Herrera Grant, A-406. IP 180.10 BOPD, 7/32-in., 46.5°, perforations 5,228-34 ft. TD 9,516 ft. (New field.)

SOUTHWEST TEXAS

Bexar County: Hillsman-Greenburg 1 Mahla, F. Rodriguez Sur. 6, A-15. IPP 91.83 BOPD, 30°, open hole 1,123-80 ft. TD 1,180 ft. (New field.)

Caldwell County: James W. Burke 1 Nancy, Elizah Curtis Sur., A-65. IP 142 BOPD, 5/32-in., 36°, perforations 2,309-13 ft. TD 2,515 ft. (New field.)

Hidalgo County: P. H. Welder 1 Davis et al., G. O. Newman Subd., Hidalgo County School Lands, Sec. 7, Blk. 2. (1 mile S of McCook). Shut-in gas well, no gage, perforations 5,495-99 ft. (basal Frio). TD 5,750 ft. (New field.)

Wilson County: O. G. McClain-Farenthold-Pitcairn 1 Cobb, J. Erskine Sur., A-100. IP 117.6 BOPD, P-43 choke, 31°, perforations 4,790-4,800 ft. (Poth A sand). TD 4,915 ft. (New field.)

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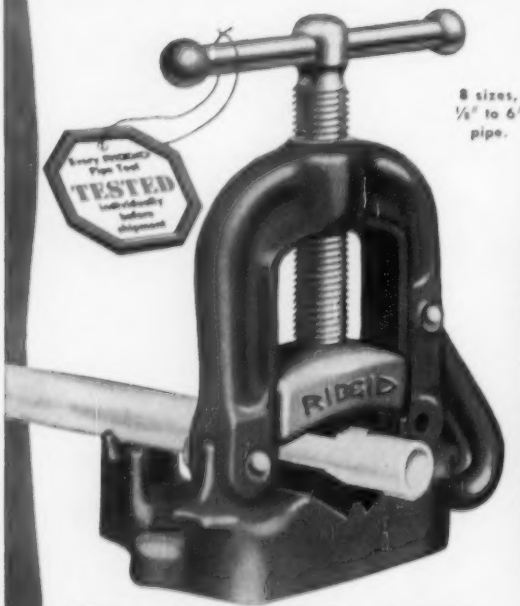

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A.A.P.G.—S.E.P.M. PROGRAM

Chicago Meet Offers Wide Range of Subjects

HERE are the papers to be presented at the American Association of Petroleum Geologists' forty-first annual meeting, and the Society of Economic Paleontologists and Mineralogists' thirtieth annual meeting at the Conrad Hilton Hotel, Chicago, April 23-26.

Tuesday, April 24

Scientific Manpower and National Safety . . . B. F. Hake, Chairman, A.A.P.G. Committee on National Responsibility.

Geophysical Data for Geological Study . . . Robert C. Dunlap, Jr., president, S.E.G.

In Defense of Outdoor Geology . . . Francis J. Pettijohn, president S.E.P.M.

A Blueprint for the Future . . . G. M. Knebel, president, A.A.P.G.

The American Association of Petroleum Geologists

Problems of Carbonate Rock Porosity and Permeability . . . Theodore A. Link, Link, Downing & Cooke, Ltd., Calgary.

Classification of Porosity and Fractures in Reservoir Rocks . . . W. A. Waldschmidt, consultant; P. E. Fitzgerald and C. L. Lunsford, Dowell Incorporated.

Dolomitization in Relation to Porosity in Carbonate Rocks . . . Leslie V. Illing, consultant to Shell Oil Co., Calgary.

Nature of Porosity and Permeability in the Edwards Formation, Texas . . . Dan E. Feray and Henry F. Nelson, Magnolia Petroleum Co., Dallas.

Sealing Mechanism in Mississippian Carbonates at the Unconformity in the Alida-Nottingham Area of Saskatchewan . . . Robert G. Lill, Imperial Oil, Ltd., Toronto.

Limestone Pore Space Studies, motion picture prepared by Stanolind Oil & Gas Co. Introduced by Robert Reynolds, Jr.

Discussion of Research Committee Symposium on Porosity and Permeability of Carbonate Rocks.

Wednesday, April 25

Photogeologic Exploration in Covered Basin areas . . . Charles DeBlieux, consultant, New Orleans.

Differential Entraptment: New Exploration Tool . . . William C. Gussow, consultant, Calgary.

Future of the Louisiana Offshore Oil Province as Predicted by Analysis of its Onshore Counterpart . . . Gordon L. Atwater, consultant, New Orleans.

Separation and Interpretation of Regional and Local Effects in Facies Maps . . . William C. Krumbein, Northwestern University.

Superposed Geologic Data as an Exploration Tool . . . Claude W. Shenkel, Jr., Kansas State College.

Geochemical Investigation of Crude Oils . . . L. C. Bonham, California Research Corp., La Habra.

Uranium, Radium, and Radon in a Well in the Panhandle Gas Field of Texas . . . G. E. Manger, U.S.G.S., Washington.

Relationship of Study of Modern Lake Sediments to Recognition of Nonmarine Source Beds . . . F. M. Swain, department of geology, University of Minnesota, Minneapolis.

A Different Stratigraphic Interpretation for the Trias-Permo-Pennsylvanian Sequence in Northern Wyoming and Adjacent Areas . . .

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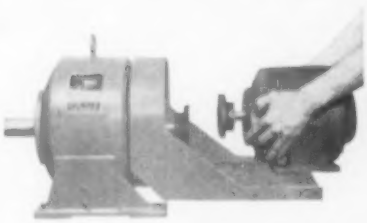

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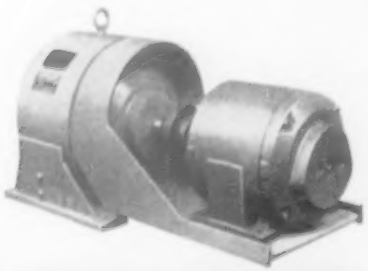

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Arthur C. Munyan, Sohio Petroleum Co., Billings, Mont.

Petroleum Sealing Factors in the Western Canada Sedimentary Basin ... William B. Gallup, Gallup, Buckland & Farney, Ltd., Calgary.

Mississippian Oil Fields of Northeastern Williston Basin ... Walter Johnson, Sohio Petroleum Co., Billings, Mont.

Sealing Factors for Nonstructural Paleozoic Oil in the Paradox Basin of the Four Corners Region ... Sherman A. Wengerd, University of New Mexico, Albuquerque.

Faults as Sealing Factors and as Channels for Migration of Fluids in Intermontane Basins of Wyoming ... John R. Fanshawe, consultant, Billings, Mont.

Physical Conditions of Sealing Beds for Gas Storage Reservoirs ... Carl A. Bays and M. William Pullen, Jr., Carl Bays Associates, Urbana, Ill.

Redfield Gas Storage Structure ... A. R. Erickson and R. F. Svoboda, Northern Natural Gas Producing Co., Omaha.

Effective Seals Above Chester Sandstones of the Eastern Interior (Illinois) Basin ... David H. Swann, Illinois Geological Survey.

Sealing Factors in the Buford or Barnett Creek Pool in Ohio County, Kentucky ... Frank H. Walker, Kentucky Geological Survey.

Thursday, April 26

Trap Barriers-Sieves or Seals? ... Gilman A. Hill, Petroleum Research Corp., Denver.

Sealing Agents in the Olmos Sands of Southwest Texas ... J. E. Glover, Ohio Oil Co., San Antonio.

Unconformity Traps Around Piercement Salt Domes in South Louisiana ... J. Roy Jackson, Jr., Humble Oil & Refining Co., New Orleans.

Factors Relating to Fault Seals in Some California Oil Fields ... A. F. Woodward, Union Oil Co. of California.

Carbonate Cementation as a Sealing Factor in Oil Accumulation, Southwest Virginia ... Ralph L. Miller, U.S.G.S., Washington.

Sealing Factors in Southwest Iranian Oil Fields ... S. Elder, British Petroleum, Ltd., London.

Some Problems Concerning Sealing Factors by Jurassic Anhydrite in the Persian Gulf ... R. M. Ramsden, Iraq Petroleum Co., Ltd., London.

Exploratory Drilling in 1955 ... Frederic H. Lahee, chairman, A.A.P.G. Committee on Statistics of Exploratory Drilling, Dallas.

Panel Discussion of Papers on Sealing Factors.

Society of Economic Paleontologists and Mineralogists

Monday, April 23

Flume Experiments on the Production of Stratification and Cross-Stratification ... Edwin D. McKee, U.S.G.S., Washington.

Sand-Grain Orientation and Geological Applications ... Gene A. Rusnak, Scripps Institution of Oceanography, La Jolla, Calif.

Grain Orientation Studies of Recent Sands ... Joseph R. Curray, Scripps Institution of Oceanography.

Directional Properties of Some California Sandstones ... L. C. Bonham, California Research Corp., La Habra, Calif.

Oriented Phenomena Produced by Sedimentation From Turbidity Currents and in Subaqueous Slope Deposits ... John E. Sanders, Yale University.

Tracing Turbidity Current Deposits Down the Slope of an Alpine Basin ... Albert Carossi, University of Illinois.

Tuesday, April 24

Ecological Interpretation of the Pliocene and Pleistocene Stratigraphy in the Great Plains Region ... John C. Frye, Illinois State Geological Survey, and A. Byron Leonard, University of Kansas.

Problem of Scientific Nomenclature Applicable to Fragmentary Fossils ... Raymond C. Moore, University of Kansas, and P. C. Sylvester-Bradley, University of Sheffield, England.

Significance of Living Foraminiferal Populations Along the Central Texas Coast ... Fred B. Phleger, Scripps Institution of Oceanography.

Paleoecology of the Florida Miocene ... Harbans S. Puri and Robert O. Vernon, Florida Geological Survey, Tallahassee.

Sedimentary Reflections of the Depositional Environment in a Coastal Lagoon ... Harris B. Stewart, Jr., Scripps Institution of Oceanography.

Recent and Ancient Penetrants ... Maxim K. Elias, University of Nebraska.

Marine Ecology as an Aid in the Teaching of Invertebrate Paleontology and Stratigraphy ... William H. Matthews III, Lamar State College of Technology, Beaumont.

Wednesday, April 25

Marine Level-Bottom Animal Communities of Recent Seas ... Gunnar Thorsen, Copenhagen Zoological Museum, Copenhagen.

Conditions of Life in the Sea ... Joel W. Hedgpeth, Scripps Institution of Oceanography.

Paleoecological Evidence Furnished by Fossils ... Harry S. Ladd, U.S.G.S.

Paleoecological Evidence from Sediments ... Bernhard Kummel, Harvard University.

Diatoms as Paleoecological Indicators ... Kenneth E. Lohman, U.S.G.S.

New Techniques in Paleoecology ... Philip H. Abelson, Geophysical Laboratory, Carnegie Institution of Washington.

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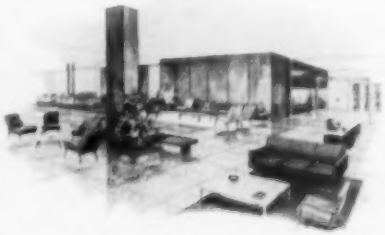

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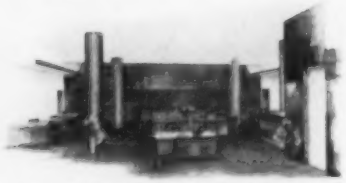

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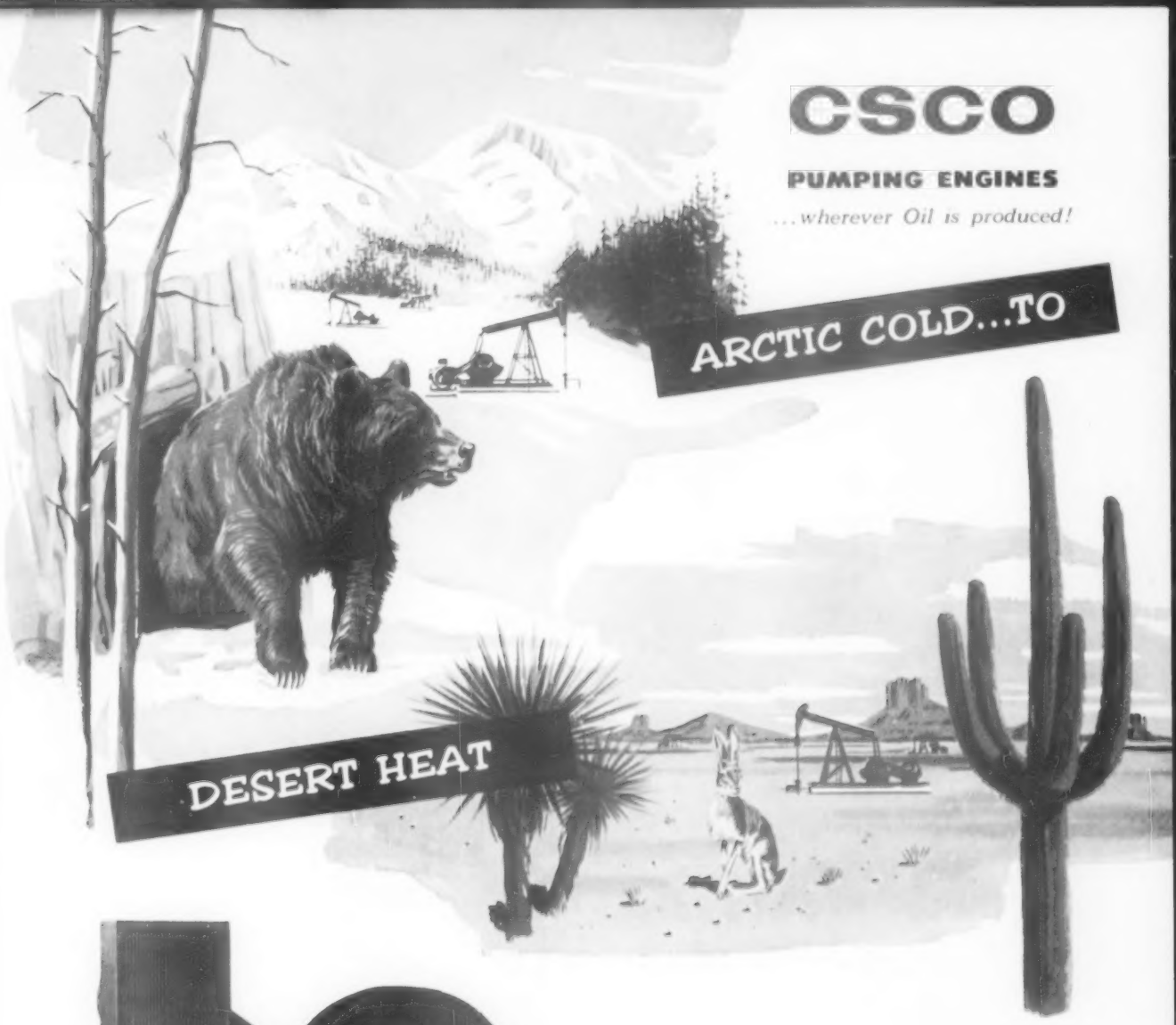

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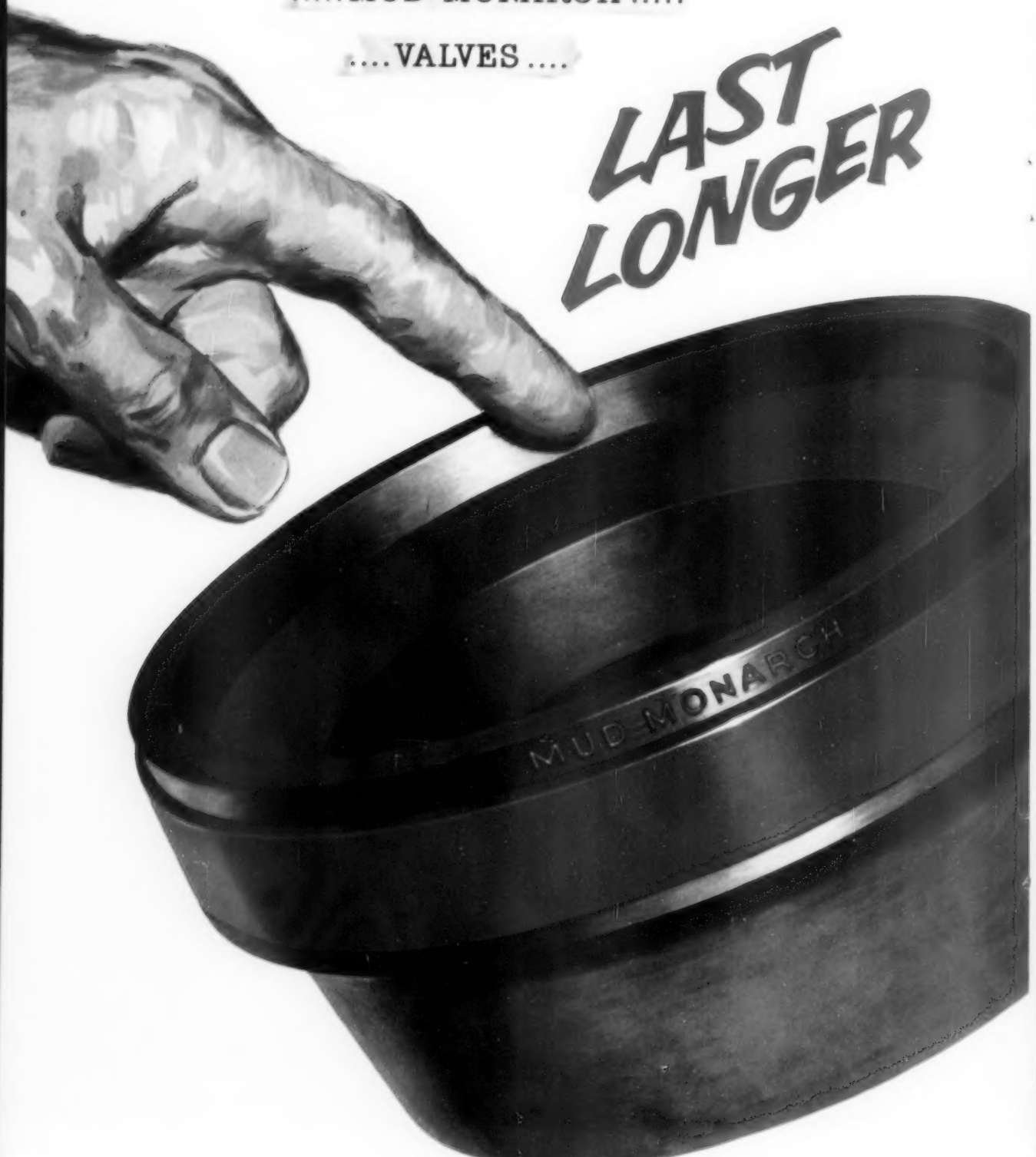

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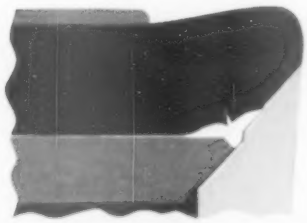

With wear, however, an opening forms at the junction of valve body, seat and sealing element. High pump pressures force part of the rubber sealing element into this space and it is pinched off. The result is short life for both sealing element and valve.

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Uniformitarianism is a Dangerous Doctrine . . . Paul D. Krynine, Penn State University.

Tertiary Reef Limestones from Southern Louisiana and Guam . . . McLain J. Forman c/o Gordon Atwater, consulting geologist, New Orleans, and Seymour O. Schlanger, U.S.G.S.

The Mineralogy of the Funafuti Drill Cores and Its Bearing on the Physicochemistry of Dolomite . . . Rombert F. Schmalz, Belmont, Mass.

Heavy-Mineral Assemblages of the Coral Reef Limestones at the Base of the Trichinopoly Cretaceous, South India . . . C. Gundu Rao, Penn State University.

Petrography and Genesis of the Ogallala "Algal Limestone" in Kansas and Adjacent States . . . Ada Swinford, State Geological Survey of Kansas; John C. Frye, Illinois State Geological Survey; and A. Byron Leonard, University of Kansas.

Shelf-Edge, Calcareous Prominences in the Northeastern Gulf of Mexico . . . John C. Ludwick and William R. Walton, Gulf Research & Development Co., Houston.

Silurian Reefs of the Northern Edge of the Eastern Interior Basin . . . John B. Sangree, Jr., Northwestern Unievrsity.

Transitional Permo-Pennsylvanian Sediments of the Rowe-Mora Basin, New Mexico . . . Raymond Sidwell and G. Frederick Warn, Texas Tech, Lubbock.

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Alice in Graywackeland . . . Paul D. Krynine, Penn State University.

Relation of Petrology and Structure to Productivity in a Stratigraphic Trap, Lindemann Oil Field, Runnels County, Texas . . . Morton K. Blaustein, Midland.

Permeability Loss From Swelling of Matrix Clays in Sub-Graywackes . . . G. Harvey Hamilton, Union Oil Co., and George R. Downs, consulting geologist.

Differential Compaction of Pennsylvanian Sediments in Relation to Sand-Shale Ratios, Jefferson County, Illinois . . . Joseph C. Mueller, Continental Oil Co., Oklahoma City, and Harold R. Wanless, University of Illinois.

Clay-Mineral Composition of Recent Sediments From the Mississippi River Delta . . . W. D. Johns, Jr., and R. E. Grim, University of Illinois.

Environmental Conditions Affecting the Deposition of Beach Sands Between Virginia and Florida . . . Suzanne F. Bershad and John K. Duncan, Division of Oceanography, U.S. Navy Hydrographic Office.

Middle Paleozoic Tectonic History of North-Central and Northwestern Utah . . . James E. Brooks, Southern Methodist University.

Triassic in the Eastern Great Basin . . . David L. Clark, University of Iowa, and William Lee Stokes, University of Utah.

Identification of Ostracode Genera and Species in Thin Sections . . . Stuart A. Levinson, Humble Oil & Refining Co., Houston.

A Faunule of Unusual Nonmarine Ostracoda From the Pliocene of Idaho . . . Daniel J. Jones and Norman R. Anderson, University of Utah.

Conodonts From the Type Chester, Illinois . . . Carl B. Rexroad, Texas Technological College.

Upper Devonian Substages and Their World-Wide Correlation on the Basis of Conodonts . . . Klaus J. Mueller, University of Iowa.

Specific Variations Among Arenaceous Silurian Foraminifera from Illinois . . . Howard Schwalb and Charles Collinson, Illinois State Geological Survey.

Acanthocladia Guadalupensis Girty, A Possible Algalbryozoan Symbiot . . . J. Keith Rigby, Brigham Young University.

Dendraster: A Problem in Echinoid Taxonomy . . . D. M. Raup, Harvard University.

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TULSA . . . MEMPHIS

Once a boy wonder of oil . . .

. . . Taylor Fighter for Freedom

REESE H. TAYLOR, president of Union Oil Co. of California, is a man who cherishes his independence. And his company policies reflect this attitude.

Several days ago when Union sold $120 million worth of its debentures to Gulf Oil Corp. Taylor made one thing clear: "This is not a merger. Union retains its historic independence of management, policies, and operations."

Taylor particularly rises up to swat down every threat to the independence of the oil industry from government control of any description.

When the Navy asked Congress for funds to wildcat on San Nicolas Island off the California coast, Taylor branded it "another government invasion of competitive private enterprise." He added "the Navy's project would unfairly impose on the taxpayer the risks and uncertainties involved in wildcatting."

On freedom's side . . . The Union president also is on the side of full freedom of operation in the current battle in California over a conservation law.

He says conservation is an engineering problem and claims any effort to write conservation into law is a threat to the freedom of the oil industry in California (see page 122).

Californians will vote on the issue in November. The proposal sets up legal machinery to force unitization of an oil pool if 75 per cent of the operating and royalty interests agree. Taylor characterizes this feature "unnecessary and contrary to the spirit of free enterprise." He claims "we have proven we can accomplish the same ends better by voluntary means."

Taylor sums up his business philosophy this way: "Our greatest gains, and those of the nation, have been made as free men working for the common good. In this endeavor, too, we must accept our responsibilities while maintaining our freedom."

Boy wonder . . . Who is Taylor? He is a veteran oil executive now. But in 1938 he was the "boy wonder of the oil industry"—president of a big company at the age of 38.

Taylor was born in Los Angeles on July 6, 1900. Except for a few years in college and a stint in World War I, he has lived and worked all his life in the state.

He was educated in Los Angeles schools, attended Cornell University 3 years, and after his Army duty was graduated from the University of California in 1922.

Taylor cut his teeth in the tough iron and steel industry. After graduation he went to work for Llewellyn Iron Works. He stayed on when the firm was merged into Consolidated Steel Corp., Ltd., in 1929. He served Consolidated as production manager, vice president, executive vice president, and finally president at the age of 33.

The young business executive resigned his steel-company presidency to take over the helm of Union Oil. He has continued as president and director ever since, helping Union grow into one of the west's largest independent oil firms.

Busy man . . . Taylor leads an active civic, social, and business life.

He served as chief of the iron and steel branch of the War Production Board in 1942. He is a director of the A.P.I., Brand Names Foundation, Federal Reserve Bank of San Francisco, Freedoms Foundation, Inc., Hollywood Bowl Association, Los Angeles Turf Club, Western Oil and Gas Association, and Y.M.C.A. of Los Angeles.

Taylor also is a member of the A.I.M.E., A.S.M.E., Business Advisory Council for the Department of Commerce, Cornell University Council, National Industrial Conference Board, and the National Petroleum Council.

He lives in suburban San Marino and maintains membership in 15 social and service clubs in Los Angeles, San Francisco, New York, Washington, D. C., and Fort Worth, Tex.

Personals

Theo. A. Morgan, retired conservation director for Kansas' Corporation Commission, has become an independent operator in Wichita.

Donald W. Spencer, Strong City, Kans., and L. (Santa Fe) Spencer, Wichita, have formed the Santa Fe Oil Co. in Wichita. The firm will operate in Kansas and Oklahoma.

Dan McMillan has been transferred by Petroleum, Inc., from Denver to Oklahoma City as district geologist. **Toby Elster,** geologist for the firm in Wichita, has resigned to become a consultant there.

G. A. Ayling, superintendent of Stanolind Oil & Gas Co.'s Three Bar gasoline plant, Kermit, Tex., and **M. W. Bretz,** superintendent at the Salt Creek gas plant, Midwest, Wyo., have swapped jobs.

Richard L. White has been promoted to senior research chemist in Magnolia Petroleum Co.'s field research laboratories, Dallas. He will continue seeking analytical data on products derived from the in-situ combustion recovery field tests being conducted near Commanche, Okla.

H. W. Brown, a director of Carter Oil Co. since 1954, has been named European and African representative on the New York staff of the production coordinator, Standard Oil Co. (N. J.). **Merrill W. Haas,** Carter exploration manager, was elected a director to succeed Brown. Brown joined Carter in 1935 as a seismograph party chief after 7 years with Humble Oil & Refining Co. He was made assistant foreign operations supervisor in 1945, and later became chief geophysicist. He was named exploration manager in 1953. Haas was named chief geologist for Carter in 1951 after 2 years on the Jersey Standard Exploration staff in New York. Earlier he had served 15 years with Creole Petroleum Corp. and predecessors in Venezuela. He's been Carter exploration chief since 1953.

H. W. BROWN

M. W. HAAS

Personals

Jack Leveritt has resigned from Witco Oil & Gas Co., Amarillo, to join Northern Natural Gas Co. as field representative for the gas-supply department, Midland, Tex. He'll perform the same duties for Permian Basin Pipeline Co., a Northern subsidiary.

Roy J. Diwoky, executive vice president of Pan-Am Southern Corp., on May 1 will become general manufacturing manager of American Oil Co. The appointment stems from the consolidation of nine Standard Oil Co. (Ind.) subsidiaries into four companies. Pan-Am will be merged into American.

Kenneth E. Kingman and **Dudley Tower,** vice presidents of manufacturing and production, respectively, of Union Oil Co., have been elected to new seats on the board of directors.

R. C. Barley has resigned as process engineer for Foster-Wheeler Corp., New York, to join American Cyanamid Co. as project engineer in Boundbrook, N. J.

G. B. Scarborough has been advanced by Gulf Refining Co. from assistant zone engineer in Harvey, La., to area production foreman in Cut Off, La.

Herbert B. Steves has been advansed by Continental Oil Co. from senior production egineer in Wichita to district engineer in Oklahoma City.

Gordon M. LeBlanc, Shreveport geologist, has joined **Robert A. Stacy,** independent operator headquartered there. LeBlanc earlier was with Southwest Natural Production Co. and United Gas Corp.

Dr. Wolf Mayne has resigned as chief paleontologist and head of the geological laboratory for Venezuelan Atlantic Refining Co., Caracas. After 3 months' leave in his Switzerland home, he will start work as consultant to the exploration management of Cie d' Exploration Petroliere, Paris.

John Domercq, Jr., has resigned as vice president and a director of The California Co., New Orleans, to join Brewster-Bartle Drilling Co., Houston, as executive vice president. He'll head the firm's offshore activities. Domercq, a former vice president and director of Standard Oil of Texas, went to The California Co. last October.

C. H. Hesser has been promoted by Continental Oil Co. from division engineer in Casper, Wyo., to chief of the engineering section in Houston.

Hermann C. Shutt, formerly consultant to Webster Engineering Corp.'s Badger Process division, has opened petroleum and chemical consulting offices in Boston.

J. M. McIlvain, since 1948 chief industrial engineer for Atlantic Refining Co., has been named European representative of the research and development department. To be headquartered in Hamburg, Germany, he'll supervise licensing and use of Catforming, Atlantic's catalytic reforming process.

Clifford E. Wilson has been promoted by Continental Oil Co. from area foreman at Healdton, Okla., to senior production engineer in Ardmore, Okla.

W. W. LOWE

W. W. Lowe, vice president and director of Cities Service Petroleum, Inc., has been elected president of Wolverine Pipe Line Co., jointly owned by Cities Service, Shell Oil Co., and The Texas Co. He succeeds **C. S. Gentry,** who is retiring. Lowe, with Cities Service more than 40 years, also is a director of Cities Service Refining Corp. and Cities Service Research & Development Co. Wolverine transports products from Chicago to Detroit and Toledo.

Frank Darden has resigned as reservoir engineer for Empresa Colombiana de Petroleos in El Centro, Colombia, to join Newmont Oil Co., Fort Worth. Before going to Colombia, Darden was with Murphy Corp. and Humble Oil & Refining Co.

Walter A. Arnold, assistant refining coordinator in Standard Vacuum Oil Co.'s New York headquarters since 1953, has been named managing director of Standard-Vacuum Refining Co. of South Africa, Pty., Ltd., Durban. He succeeds **J. B. Hanna,** who will return to the United States for reassignment. Arnold joined Stanvac in 1946 after 10 years with major refineries in New Jersey and Louisiana. He served at the firm's Sungei Gerong refinery in Sumatra as refinery manager and later became assistant operations manager for Stanvac's Indonesian producing and refining subsidiary.

J. L. WINTER

J. L. Winter, chief representative of United British Oilfields of Trinidad, Ltd., Port of Spain, later this month will become administration manager for British Malayan Petroleum Co., Seria, British Borneo, and Sarawak Oilfields, Ltd., Miri/Lutong. The post carries with it a seat on each firm's board of directors. Winter succeeds **William M. Moore,** who will return to London with the parent Royal Dutch-Shell group. Winter joined Shell in 1945 and was named top man in Trinidad 8 years later. Moore, who joined the group in 1937, first went to Borneo in 1951 as assistant to the manager of B.M.P. and S.O.L. He was named manager of both in 1953.

W. L. Stanton, vice president of Texas Gas Transmission Corp., has moved his offices from Shreveport to Houston.

Ray Langen, Carter Oil Co. geologist, has been transferred from Grand Rapids, Mich., to Billings, Mont. **Bill Checkly** moves from Carmi, Ill., to replace Langen.

H. W. Prince and **M. W. Prince,** Henderson, Ky., and **Russell Wood,** Grayville, Ill., have formed the Prince & Wood Drilling Co., with headquarters in Henderson.

C. M. HARLESS

Charles M. Harless, assistant superintendent of The Texas Co.'s Port Neches, Tex., works since 1944, has been named superintendent. He succeeds R. G. Schorlemmer, who died recently. **J. T. Yardley, Jr.,** former manager of crude stills, becomes assistant manager. Harless joined Texaco in 1928 as an engineer in the Port Arthur works. He was transferred to Port Neches in 1929 and made chief engineer in 1941. Yardley joined the firm in 1938 and has been at Port Neches since 1948.

St. George Creaghe has resigned as project engineer with Standard Oil Co. (Ohio) in Cleveland to join Phillips Chemical Co. as senior design engineer in Bartlesville, Okla.

Personals

R. M. Carter has been named superintendent of a new Shell Oil Co. production district office in Abilene, Tex. The office will handle Shell's production in 43 West Central Texas counties.

Dr. Jesse D. Wizenried, former director of field service research for Tax Foundation, Inc., in New York, has joined Husky Oil Co., Cody, Wyo., as administrative coordinator.

Charles D. Fenstermaker, Stanolind Oil & Gas Co. geologist, has been transferred from Oklahoma City to Shreveport.

Victor B. Ogden and **Jack W. Williamson,** petroleum engineers, have joined Russell Engineering Co., Abilene, Tex. Ogden was with Core Laboratories 8 years. Williamson is former president of Reel Co., an oil service firm.

Charles H. Brown, recently assistant power superintendent in Atlantic Refining Co.'s Philadelphia refinery, has been promoted to power superintendent. He succeeds **W. A. Shmidheiser,** retiring after 36 years' service.

Patrick H. Feeney, director of Voss Oil Co., Newcastle, Wyo., has been elected president. He replaces **Warren G. Voss. Roy H. Bronson,** of Bronson, Bronson & McKinnon, San Francisco, was named a director. He replaces **Dr. L. W. Jamieson,** who resigned.

A.P.I. Mid-Continent Production Men Elect Wright

F. F. Wright, Sinclair Oil & Gas Co., Tulsa, left, is congratulated after being elected Mid-Continent district chairman of the American Petroleum Institute's Production Division. Others at the district's recent spring meeting in Wichita are, left from Wright: Jack Tarner, Phillips Petroleum Co., Bartlesville, Okla., past district chairman; E. W. Hughes, Sohio Petroleum Co., Pauls Valley, Okla., new district vice chairman for the Golden Trend area; W. J. Bovaird, Bovaird Supply Co., Tulsa, new district secretary-treasurer; and Fred Morton, of Glenn Gillespie & Sons, Cushing, Okla., new vice chairman for the Drumright-Perry area.

Dr. John C. Zimmer has been named assistant manager of the Socony Mobil Oil Co., Inc., laboratories. **Dallas R. Lamont,** Socony research director, will be manager. Other assignments in Socony research: **Theodore G. Roehner,** promoted from technical service department director to tech service lab manager. Brooklyn; **Edward S. Nicholls,** former administrative director, named manager of the research and development lab, Paulsboro, N. J.; and **Guy R. M. del Guidice,** promoted from patent division staff member to assistant to Lamont.

F. Kenneth Davs has been promoted by Creole Petroleum Co. from assistant manager of the Amuay, Venezuela, refinery to superintendent of the Caripito district in Eastern Venezuela. Davis joined Creole in 1949. Earlier, he had been with Humble Oil & Refining Co. in Baytown, Tex.

DEATHS

Ernest J. Nicklos, 75, chairman of Nicklos Oil & Gas Co. and Nicklos Drilling Co., Houston, died there April 7 (See page 113).

Will J. Reid, 66, board chairman of Hancock Oil Co., Long Beach, died April 8 while boarding a plane in Kansas City, Mo. With his brother-in-law, the late John Walker Hancock, Reid founded Hancock Oil in 1922 and served as president until 1953. He was an organizer of Long Beach Oil Development Co., formed in 1939 to develop that city's tidelands. He was also a director of Southwest Exploration Co.

Arthur H. Rucker, 61, with Roosevelt Materials Co., Hobart, Okla., died April 4 in Hobart. He was in the producing department of Carter Oil Co. for several years before joining Larkin Packer Co. He later spent 16 years with Broderick & Bascom Rope Co. before joining Roosevelt in 1955.

W. D. (Bill) Shirey, 68, retired president of Reserve Oil Co., Bakersfield, Calif., died there recently. Shirey, active in the industry 51 years, began in Pennsylvania at 17. He supervised the first well in Kern County's Tejon field.

Walter S. Kyle, 76, pioneer Bakersfield, Calif., independent, died there April 3.

Richard A. Rowlands, 66, Casper, Wyo., retired mechanical superintendent of the Standard Oil Co. (Ind.) Casper refinery, died recently.

Joe P. Parris, Jr., Abilene, Tex., independent, died there April 2.

Dr. Stanard G. Bargquist, 63, head of Michigan State University's department of geology since 1930, died recently while visiting relatives in Madison, Wis.

George Brimmer, Cheyenne, Wyo., attorney and active Rocky Mountain independent many years, died April 3 in Cheyenne. Brimmer had been instrumental in advancing oil legislation in the Rockies. He was a member of the Rocky Mountain Petroleum Pioneers.

Maner Graham, 49, Midland, Tex., independent, was killed recently when his private plane crashed in a residential area near Fort Worth.

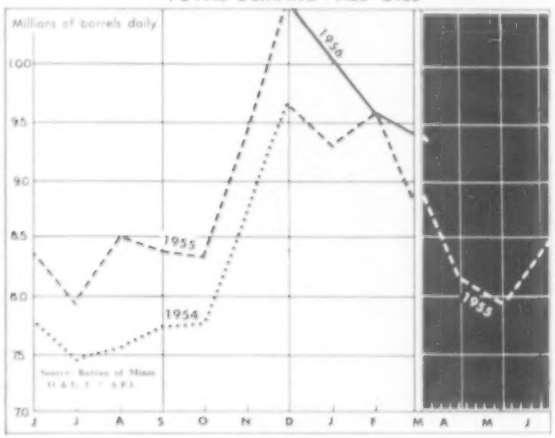
Ernest W. Roth, 66, retired General Petroleum Corp. chemist, died April 1 in Los Angeles.

Latest Figures . . . Industry Trends

A QUICK LOOK AT THE HIGHLIGHTS

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	7,195,500	UP	26,140	UP	303,510
Crude stocks	262,066,000	UP	2,029,000	DOWN	4,497,000
Completions	1,119	UP	113	UP	8
Refinery runs	7,517,000	DOWN	177,000	UP	525,000
Gasoline stocks	197,322,000	DOWN	887,000	UP	14,137,000
Kerosine stocks	17,644,000	UP	311,000	DOWN	1,052,000
Distillate stocks	60,808,000	DOWN	1,775,000	DOWN	1,126,000
Residual stocks	32,651,000	DOWN	1,245,000	DOWN	11,969,000
Four-product stocks	308,425,000	DOWN	3,596,000	DOWN	10,000
Total imports	1,363,600	UP	186,900	UP	287,000

TOTAL DEMAND – ALL OILS



Recent Reductions in Distillate Prices Are Not Regular Summer-Fill Cuts

FOR the past few years, product realization at Gulf Coast and Mid-Continent refineries has tended to follow a seasonal trend. Realization has been higher during the winter months than in the summer. These variations may stem from the fact that fuel prices tend to drop off more in the summer than gasoline in the winter.

Light fuels on the Group 3 market are down 0.25 cent a gallon, following a similar reduction on the Gulf Coast a week earlier. These reductions are end-of-season cuts and are not related to normal summer-fill discounts which start about June.

Last year No. 2 fuel dropped 0.5 cent a gallon on the Group 3 market between the end of March and the first of July. On the Gulf Coast, the over-all seasonal decrease was 1.0 cent a gallon with 0.25 cent of the drop late in March. The market regained 0.5 cent of the drop late in August. The New York Harbor barge market for No. 2 fuel skidded 0.65 cent a gallon in April but picked up 0.25 cent of the loss in August.

Discounts for summer fill this year may be influenced by continuing discussions of a probable increase in crude prices. If crude prices have not advanced by the time summer-fill discounts are announced, there will be some incentive for jobbers to promote early consumer purchases and to keep all available secondary storage filled.

In the past, most of the home-heating fuel contracts with consumers have called for billing at the price existing at the time of sale or the lowest price between delivery and the end of the discount season. These contracts give the customer the benefit of any price reductions but do not protect him against price increases. Summer fills will be easier to sell if there is a chance of an increase during the summer.

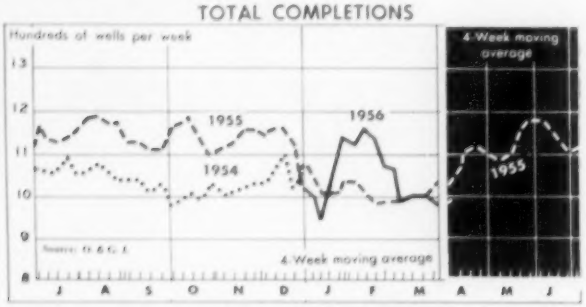
If crude prices advance before the summer-fill season, discounts will be made from corrected distillate quotations, based on the new crude price.

Group 3 gasoline prices expected to rise . . . Premium gasoline, rated at 96 octane, started moving in the Great Lakes pipeline on April 2, and 88-octane regular will start April 16. The improved premium is not available at all terminals and so there has been no price recognition of the higher quality. Some marketers have predicted that increases for both premium and regular will be announced at the same time. If the increase is delayed until all of the old 86-octane regular has been moved at all terminals, the raise can't come much before the end of April.

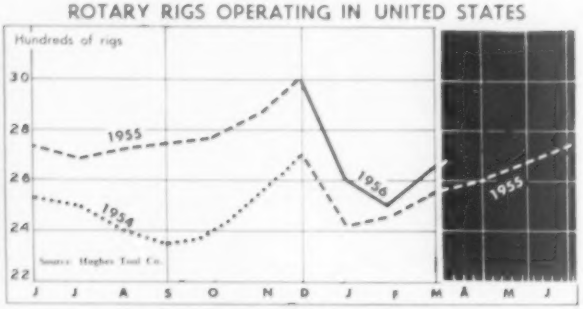
Except for premium grade late in the month, the pending price increase will not have much effect on jobber purchases for increasing inventories. Most of them are expecting higher prices, but do not want heavy inventories of 86-octane regular on hand after the 88-octane grade becomes general.

Tanker rates are holding 20 per cent above the Maritime Commission base rates. Also, rates reported for May liftings indicate a firm tanker market for at least another month.

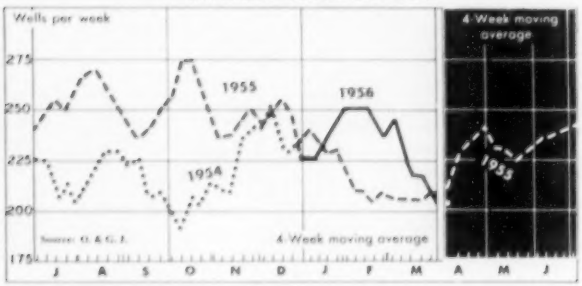
TOTAL COMPLETIONS



ROTARY RIGS OPERATING IN UNITED STATES



WILDCAT COMPLETIONS



ACTIVE ROTARY RIGS*

Area—	4-9-56	Change from 4-2-56	Change from 4-11-55
Gulf Coast	651	1	70
N. and W. Texas-New Mexico	937	—13	65
Arkansas-N. Louisiana-E. Texas	160	2	—13
Oklahoma	323	—13	
Kansas-S. Nebraska	176		—15
Illinois-Eastern	107	—7	—24
Rocky Mountain	197	—3	—16
Pacific Coast	131	3	—23
Total United States	2,682	—30	44
Western Canada	125	—23	—23

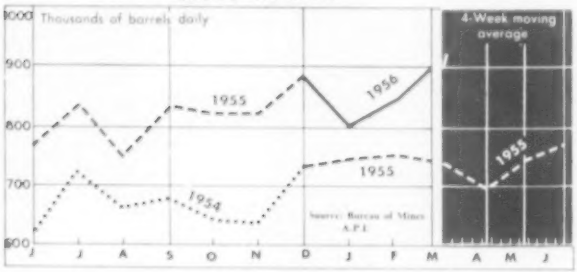
*Hughes Tool Co.

WEEKLY WELL COMPLETIONS . . . WEEK ENDED APRIL 7, 1956

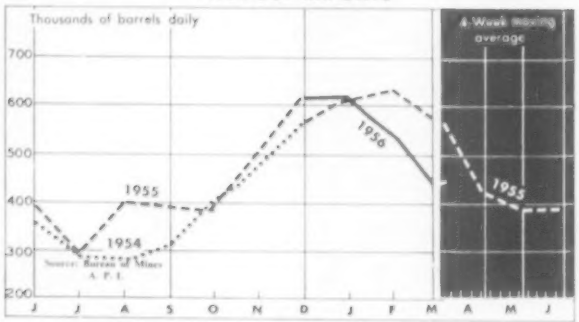
	Total of all wells: Comp.	Oil	Gas	Dry	Footage	Cum. 1956	Cum. 1955	Wildcat completions and discoveries: Oil	Dist.	Gas	Dry	Total	Cumulative total, 1956: Oil	Dist.	Gas	Dry	Total
Ala.-Ga.-Fla.	2	0	0	2	8,185	26	31	0	0	0	2	2	0	0	1	15	16
Arkansas	12	6	0	6	46,644	199	170	0	0	0	1	1	10	0	2	29	41
California	57	38	0	19	311,423	564	672	0	0	0	16	16	10	0	0	111	121
Colorado	26	12	1	13	141,222	292	332	1	0	0	10	11	5	0	3	135	143
Illinois	38	17	3	*18	87,355	866	969	1	0	0	7	8	12	0	0	136	148
Indiana	6	2	0	4	12,507	163	194	1	0	0	1	2	5	0	1	33	39
Kansas	127	63	10	154	407,958	1,338	1,339	4	0	0	20	24	28	1	9	228	266
Kentucky	27	14	0	13	26,906	446	339	0	0	0	5	5	9	0	0	103	112
Louisiana	51	29	2	20	383,085	1,018	1,012	1	1	1	5	8	30	18	9	127	184
North	17	11	0	6	61,497	373	529	1	0	0	1	2	8	0	0	41	49
South	30	16	1	13	274,671	517	483	0	1	0	4	5	20	16	5	75	116
Offshore	4	2	1	1	46,917	128		0	0	1	0	1	2	2	4	11	19
Michigan	9	3	1	5	20,620	136	140	0	0	0	3	3	3	0	0	44	47
Mississippi	9	4	0	5	93,853	115	128	0	0	0	4	4	4	0	1	45	50
Montana	2	1	0	1	12,437	93	90	0	0	0	1	1	5	0	0	23	28
Nebraska	21	5	0	16	115,510	232	168	1	0	0	14	15	11	0	0	114	125
New Mexico	24	17	4	3	94,323	465	335	0	0	0	1	1	9	0	5	41	55
Northwest	5	0	4	1	22,724	152	87	0	0	0	0	0	0	0	5	13	18
Southeast	19	17	0	2	71,599	313	248	0	0	0	1	1	9	0	0	28	37
North Dakota	9	7	0	2	70,093	59	53	0	0	0	0	0	2	0	0	12	14
Ohio	21	13	1	*7	55,352	285	281	0	0	0	0	0	0	0	1	2	3
Oklahoma	155	105	16	134	572,399	2,339	2,243	1	0	1	10	12	41	8	8	190	247
Pennsylvania-New York	3	0	3	0	8,253	212	422	0	0	0	0	0	0	0	1	2	3
Texas	495	326	17	152	2,112,716	5,750	5,162	19	0	4	83	106	229	19	51	1,240	1,539
Southwest (1 & 4)	76	45	3	28	243,320	857	820	5	0	1	14	20	47	5	18	252	322
Gulf Coast (2 & 3)	57	28	9	20	396,516	720	683	2	0	2	13	17	20	8	19	190	237
East (5 & 6)	19	9	0	10	90,592	306	281	1	0	0	5	6	3	1	4	113	121
North Central (7-B & 9)	168	96	2	70	507,472	1,975	1,818	9	0	1	30	40	99	0	2	461	562
West (7-C & 8)	157	132	2	23	815,452	1,579	1,283	2	0	0	20	22	59	0	6	206	271
Panhandle (10)	18	16	1	1	59,364	313	277	0	0	0	1	1	1	5	2	18	26
Utah	0	0	0	0	0	19	14	0	0	0	0	0	1	0	0	15	16
West Virginia	13	0	10	3	36,606	190	163	0	0	0	0	0	0	0	2	3	5
Wyoming	12	7	1	4	49,947	193	226	0	0	0	3	3	4	0	4	60	68
Miscellaneous	0	0	0	0	0	49	8	0	0	0	0	0	4	0	0	36	40
Total United States	**1,119**	669	69	381	4,667,394	‡15,049	‡14,491	29	1	6	186	**222**	422	46	98	2,744	‡3,310
Total previous week	1,006	571	61	374	3,988,510			25	5	7	170	207	394	44	92	2,558	3,088
Total April 9, 1955	1,111	636	71	404	4,370,213			33	6	9	199	247	403	53	93	2,475	3,024
Cumulative 1956	‡15,049	8,347	982	5,720	62,058,958												
Western Canada	53	31	1	21	296,751	634											

Service wells included: *1, 15. ‡Revised for first quarter.

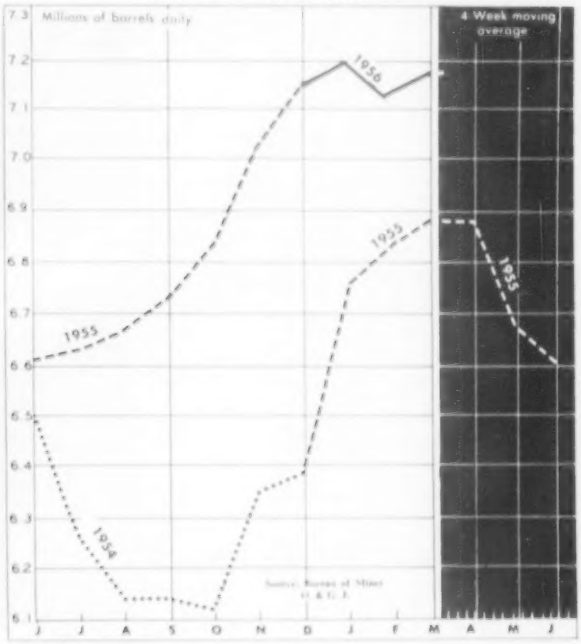
CRUDE IMPORTS



PRODUCT IMPORTS



CRUDE-OIL PRODUCTION



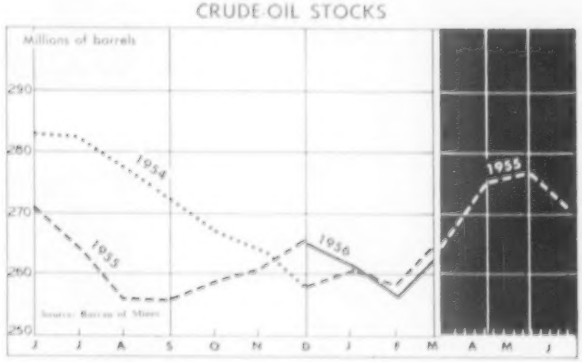
DAILY AVERAGE PRODUCTION FOR WEEK

	April 7			Mar. 31
	Crude oil	Lease condensate	Total	total
Alabama	5,000		5,000	4,800
Arkansas	72,400	500	72,900	72,400
California	967,200		967,200	965,600
Colorado	160,500		160,500	162,200
Eastern	48,400		48,400	49,100
Florida	1,325		1,325	1,400
Illinois	238,900		238,900	232,000
Indiana	31,100		31,100	32,700
Kansas	335,600		335,600	345,600
Kentucky	47,200		47,200	47,400
Louisiana	757,850	69,200	827,050	820,300
North	117,850	2,200	120,050	120,300
South	640,000	67,000	707,000	700,000
Michigan	29,900		29,900	29,300
Mississippi	107,400	4,400	111,800	110,800
Montana	56,300		56,300	52,400
Nebraska	37,400		37,400	29,500
New Mexico	249,150	4,250	253,400	245,300
North Dakota	37,700		37,700	38,400
Oklahoma	607,300		607,300	615,700
Texas	2,982,200	52,825	3,035,025	3,028,400
Dist. 1	54,500	450	54,950	54,550
Dist. 2	151,000	8,500	159,500	159,450
Dist. 3	429,000	25,400	454,500	456,300
Dist. 4	244,000	5,000	249,000	252,400
Dist. 5	45,000	475	45,475	47,500
Dist. 6	125,700	5,900	131,600	136,200
East Texas field	215,600		215,600	220,500
Dist. 7-B	161,000	50	161,050	163,050
Dist. 7-C	189,000	4,400	193,400	181,700
Dist. 8	1,060,000	1,875	1,061,875	1,051,950
Dist. 9	213,000	600	213,600	210,600
Dist. 10	95,000	175	95,175	94,200
Utah	5,100		5,100	4,900
Wyoming	286,200		286,200	280,800
Others	1200		200	360
Total U. S.	7,064,325	131,175	**7,195,500**	7,169,360
Change from previous week, up			**26,140**	
Canada	†394,940		†394,940	†473,500

Total U. S. production January 1-April 7 ..... 696,614,030 bbl.
Same period last year (crude plus cond.) ..... *662,381,120 bbl.

*Includes 11,203,350 bbl. condensate. †Week ended previous Monday. ‡Nevada.

CRUDE-OIL STOCKS



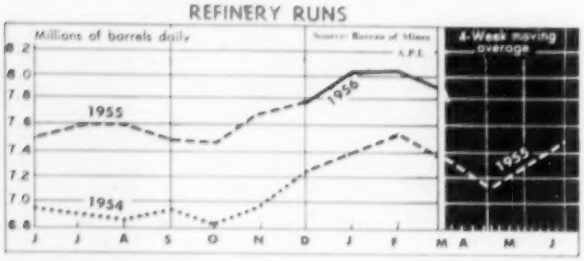
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

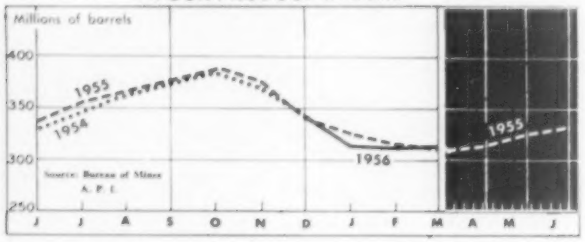
	3-31-56	3-24-56	4-2-55
Pennsylvania Grade	2,588	2,683	2,788
Other Appalachian	2,161	2,108	2,059
Illinois, Indiana, Michigan	9,174	9,604	10,888
Nebraska, North Dakota	2,018	2,079	1,661
Kansas	7,792	7,646	8,064
Oklahoma	23,440	23,506	24,544
Arkansas	2,632	2,702	2,990
Louisiana	16,410	15,984	14,878
North	2,594	2,583	2,421
South	13,816	13,401	12,457
Mississippi	3,138	3,101	2,884
New Mexico	7,674	7,608	8,309
Texas	123,685	121,615	122,564
East Texas proper	9,345	9,279	10,214
West Texas	60,770	59,668	53,993
Texas Gulf	21,746	21,900	23,682
Other Texas	31,824	30,768	34,675
Wyoming	15,921	15,884	14,278
Other Rocky Mountain	5,586	5,448	5,855
California	27,976	28,189	33,194
Foreign	†11,871	11,880	11,607
Total	262,066	260,037	266,563

*Bureau of Mines. †Includes 1,732,000 bbl. in California.

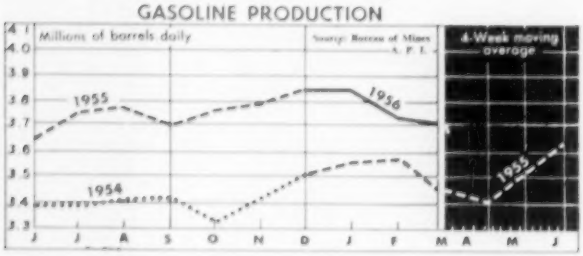
REFINERY RUNS



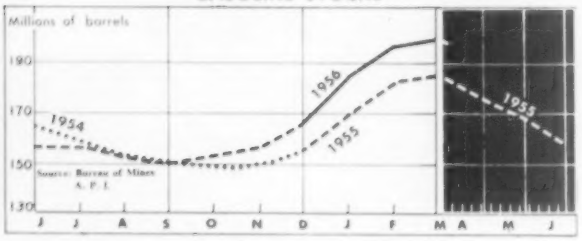
FOUR-PRODUCT STOCKS



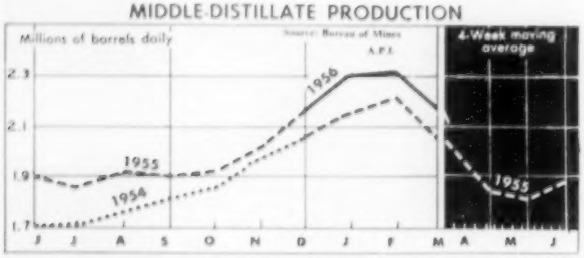
GASOLINE PRODUCTION



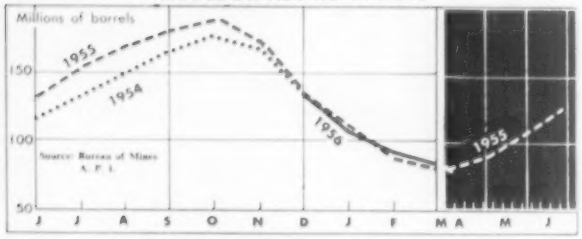
GASOLINE STOCKS



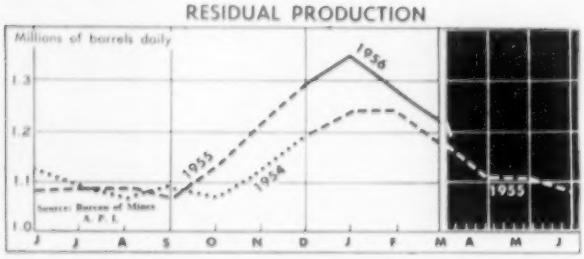
MIDDLE-DISTILLATE PRODUCTION



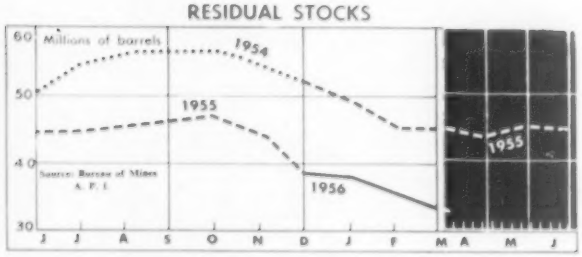
MIDDLE-DISTILLATE STOCKS



RESIDUAL PRODUCTION



RESIDUAL STOCKS



A.P.I. REFINERY REPORT, APRIL 6

(Thousands of barrels)

District—	Daily avg. runs	Daily average production—Gaso.*	Kero.	Dist.	Resid.	Stocks‡—Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, April 1955—Daily avg. runs	Daily average production—Gaso.*	Kero.	Dist.	Resid.
East Coast	1,030	407.4	37.3	262.9	196.9	40,380	7,103	18,403	8,376	996	398.9	26.5	248.7	203.6
Appalachian:														
District 1	87	34.4	4.0	20.0	8.1	4,880	381	1,078	280	100	41.2	3.9	23.9	7.6
District 2	101	50.9	7.9	20.4	17.0	3,161	401	632	294	82	44.7	4.9	13.9	13.2
Ind., Ill., Ky.	1,363	728.6	76.9	269.6	189.2	41,969	3,210	9,700	3,549	1,262	650.3	66.1	240.8	155.3
Okla., Kans., Mo.	675	376.7	20.4	169.7	16.0	22,638	738	7,133	1,007	591	317.2	16.4	136.5	35.9
Inland Texas	242	176.9	12.7	45.0	23.9	7,537	358	1,149	1,358	259	192.2	11.0	46.0	19.2
Texas Gulf Coast	1,957	912.7	91.9	539.4	232.7	27,511	2,667	7,662	4,915	1,793	819.4	112.3	412.6	238.0
La. Gulf Coast	699	371.4	70.4	155.2	49.1	10,728	1,711	4,093	1,492	643	337.0	53.3	160.7	34.7
N. La. and Ark.	71	25.7	5.4	17.1	3.0	4,510	446	977	40	86	31.0	7.9	21.7	6.1
Rocky Mountain:														
New Mexico	23	12.1		4.1	3.0	283	8	85	36	21	11.0	0.3	3.5	2.8
Other Rocky Mtn.	202	97.9	3.7	49.3	35.3	8,320	269	2,047	907	226	94.0	3.8	57.7	31.5
California	1,067	459.4	4.0	186.4	305.7	25,405	352	7,849	10,397	1,077	472.4	6.0	168.5	361.7
Apr. 6, 1956	7,517	3,654.1	334.6	1,739.1	1,079.9	197,322	17,644	60,808	32,651	7,136	3,409.3	312.4	1,534.5	1,109.6
Mar. 30, 1956	7,694	3,634.9	319.7	1,719.0	1,172.1	198,209	17,333	62,583	33,896					
Apr. 8, 1955	6,992	3,347.7	328.6	1,586.4	1,184.7	183,185	18,696	61,934	44,620					

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipelines.

Crude-oil and refinery prices at representative U. S. and foreign points

REFINED-PRODUCT PRICES

Following quotations are for refinery products in cents per gallon moving in interstate shipments on Wednesday each week unless otherwise noted. Crude-oil prices are per barrel at the wells unless otherwise listed.

GASOLINE*

Mid-Continent (Group 3):	
Regular (86 octane)	11.25-11.50
Premium (94 octane)	12.75-13.00
Gulf Coast (cargoes for coastwise or export movement):	
Regular (90 octane)	11.00-11.25
Premium (97 octane)	13.00-13.25
New York (barges):	
Regular (89 octane)	12.25
Premium (96 octane)	14.50
California—Los Angeles (rack):	
Regular (84 octane)	12.9-13.15
Premium (93 octane)	14.0-14.25
Caribbean area (cargoes):	
Regular (87 octane)	10.50
Premium (93 octane)	11.50

*Quotations are for octanes shown. Prices usually vary with octane ratings within the regular, premium, and aviation grades.

NATURAL GASOLINE*

Group 3:	
Grade 26-70	4.5
Breckenridge:	
Grade 26-70	4.0

*If 26-70 natural is considered as 100 per cent, prices for lower-vapor-pressure grades increase 2.5 per cent for each unit drop in Reid vapor pressure down to and including 16-lb. Prices for grades below 16-lb. may vary slightly by areas or plants.

KEROSINE AND DISTILLATE

Mid-Continent (Group 3):	
★ Kerosine 42-44	10.00-10.25
★ Diesel oil (58 d.i. and above)	9.625-9.875
★ Distillate No. 1	9.625-9.875
★ Distillate No. 2	9.00-9.25
Gulf Coast (cargoes):	
Kerosine 41-43	9.25-9.5
Distillate No. 2	8.75-9.25
New York Harbor (barges):	
Kerosine 41-43	10.85
Distillate No. 2	10.35
Diesel fuel, 48-52 d.i.	10.65
Caribbean area (cargoes):	
Distillate No. 2	8.75

WAX (I.B.)

Oklahoma (Group 3):	
132-135 A.m.p. (semi-refined) in tank cars	6.50
New York (export):	
126-130 A.m.p. crude scale (solid) in bags or barrels)	7.10

★ Denotes change from previous week.

RESIDUAL FUEL (BBL.)

Mid-Continent (Group 3):	
★ Residual fuel (max. 1% S)	$2.00-2.10
Gulf Coast (cargoes):	
Bunker C fuel	$2.10
New York Harbor (barges):	
Bunker C fuel	$2.65
Caribbean (cargoes):	
Bunker C at Aruba, N.W.I.	$2.10
California (rack):	
Bunker C fuel, Los Angeles	$2.10-2.20

LUBRICATING OILS

Mid-Continent (Group 3):	
150-160 bright stock, solvent refined, 0-10 p.p., 95 v.i.	24
200 vis. neutral oil, solvent refined, 0-10 p.p., 95 v.i.	20.75
Pennsylvania Grade:	
145-155 vis. at 210, bright stock, 8 color, 25 p.t.	24
200 vis. neutral (180 at 100°), 25 p.t.	21

CRUDE-OIL PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.	Mid-Cont.*	Gulf Coast Tex.†	West Tex.‡ N.M. (sour)	Wyo.
14-14.9	$2.02				
15-15.9	2.08				
16-16.9	2.13				
17-17.9	2.19				
18-18.9	2.24				
19-19.9	2.30				
20-20.9	2.35	$2.50		$2.37	
21-21.9	2.41	2.52		2.39	
22-22.9	2.47	2.54		2.41	
23-23.9	2.52	2.56		2.43	
24-24.9	2.58	2.58	$2.91	2.45	
25-25.9	2.64	2.60	2.93	2.47	
26-26.9	2.69	2.62	2.95	2.49	
27-27.9	2.76	2.64	2.97	2.51	
28-28.9	2.83	2.66	2.99	2.53	
29-29.9	2.91	2.68	3.01	2.55	
30-30.9	2.97	2.70	3.03	2.57	
31-31.9	3.04	2.72	3.05	2.59	$2.46
32-32.9	3.12	2.74	3.07	2.61	2.48
33-33.9	3.20	2.76	3.09	2.63	2.50
34-34.9	3.27	2.78	3.11	2.65	2.52
35-35.9	3.34	2.80	3.13	2.67	2.54
36-36.9	3.39	2.82	3.15	2.69	2.56
37-37.9		2.84	3.17	2.71	2.58
38-38.9		2.86	3.19	2.73	2.60
39-39.9		2.88	3.21	2.75	2.62
40 and up		2.90	3.23	2.77	2.64

*Includes Oklahoma, Kansas, North Dakota, West Texas (sweet), North Central Texas, North Louisiana, Arkansas, and Wyoming (sweet). †Low-cold-test Gulf Coast. ‡Sour.

Effective dates: California, February 7, 1956; east of California, June 15, 1953; Pennsylvania Grade, March 16, 1956.

FLAT PRICES

Louisiana:	
Cotton Valley (distillate)	$3.0
Cotton Valley (Holloway crude)	2.9
Texas:	
East Texas	2.90
Chapel Hill	2.83
Conroe	3.13
Van	2.73
Pennsylvania Grade:	
Bradford	4.20
Middle District	4.07
Southwest Pennsylvania	3.78
West Virginia	3.66
Buckeye Grade	3.60
Zanesville Grade	3.02
Illinois Basin	3.00
Canada:	
Leduc-Woodbend (flat prices D-2, D-3)	2.60
Redwater (Alta.) D-3	2.49
Smiley-Viking (Sask.)	2.26
Fosterton (Sask.)	1.29
Pembina	2.52

FOREIGN

Venezuela:	
Cumarebo, 48°-48.9°, Tucupido	*$3.40
San Joaquin, 41°-41.9°, Puerto La Cruz	*3.04
Oficina, 35°-35.9°, Puerto La Cruz	*2.80
Tia Juana medium, 26.5°-26.9°, Amuay	†2.30
Quiriquire, 16.5°-16.9°, Caripito	†2.21
Lagunillas heavy, flat, Amuay or Las Piedras§	2.05
Bachaquero, 16.5°-16.9°, Amuay or Las Piedras§	†1.90

*Plus or minus 2 cents per barrel for each degree gravity change. †Plus or minus 2.5 cents per barrel for each half-degree gravity change. ‡Plus or minus 3.5 cents per barrel for each half-degree gravity change. §Also available at La Salina at 3.0 cents per barrel less.

Middle East, Persian Gulf (cargoes, f.o.b. lifting port):	
Arabian, 36.0°-36.9°, Ras Tanura	$1.97
Iranian, 34.0°-34.9°, Bandar Mashur	1.91
Iranian, 34.0°-34.9°, Abadan	1.86
Iraq, 36.0°-36.9°, Fao	1.87
Kuwait, 31.0°-31.9°, Mina-al-Ahmadi	1.72
Qatar, 39.0°-39.9°, Umm Said	2.06
Middle East, E. Mediterranean:	
Arabian, 36.0°-36.9°, Sidon	2.46
Iraq, 36.0°-36.9°, Tripoli, Banias	2.46
Far East (cargoes, f.o.b. Lutong, Sarawak):	
Seria Light, 37°-38°	2.60

TANKER RATES (PER LONG TON)

(Latest reported spot fixtures)

★Gulf-U.S.N.H., clean (USMC+20%)	$3.42
★NWI-U.S.N.H., dirty (USMC+20%)	3.24
★NWI-Buenos Aires, dirty (USMC+15%)	8.28
★NWI-U.K., clean (Scale+47.5%) 47s. 11d.)	6.73
★NWI-U.K., dirty (Scale+37.5%) (44s. 8d.)	6.28
★P.G.-U.K., dirty (Scale+45%) (78s. 5d.)	11.01

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FOR SALE—At Oil Hill, Kansas: 4—Cooper type 80 twin engine compressor units, with 8½"x20" class A and 15½"x20" class C compressor cylinders. Also, 1—type 80 single DO. with 6½" and 10½" x 20" tandem compressor cylinders. All with 18" x 20" power cylinders. Cities Service Oil, Patridge, Bartlesville, Oklahoma.

Gaso Duplex 4½" x 6" Power Pumps with Chrysler C-36 Engines, skid mounted, immediate delivery. Also Byron Jackson, Carter Centrifugal Units, Westinghouse 20-25-50 KW Generating Units

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FOR SALE: Wilson-Snyder mud pump, 7¼" x 18". Top condition and less than half price. L. T. Peyton Machine Shop, Vernal, Utah. Phone 267.

FOR SALE—At Tallant, Oklahoma, three 5'x56' absorbers, 20 trays, 24" spacing 500# WP, peak design each 40,000 MCFD at 350 PSIG; oil rate 100-300 GPM, min. and max. Bought new 1947, taken out of service 1954. Price $8500.00 each, now standing. Full data upon request. Cities Service Oil, Patridge, Bartlesville, Oklahoma.

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Petro. Industries Consultants, C.A. Caracas, Venez.

1 Mayhew 1000 mounted on F8 Ford. 25 ft. mast—Power Flo pulldown with heavy pull down chains—5 x 6 Gardner-Denver mud pump, Butane equipped.

1 Model F Franks Drill with double drum hoist, 17 ft. Kelly, mounted on K-7 International. Has 4½ x 5 Gardner-Denver mud pump.

1 Young Hydraulic drill mounted on 1952 F-6 Ford. Has 4½ x 5 Gardner-Denver mud pump. Good water well drill.

Price range $3,500.00 to $7,000.00

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FAILING 1500 H.D. drill with 4½ x 5 pump, automatic pulldown, mounted on 1951 Ford. Also, Griffin water tank, mounted on 1951 Ford. Write P. O. Box 819, Longmont, Colo., Phone 1333.

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FOR SALE—Two No. 110 Rilse natural gas drilling engines. One has never been used after having been factory re-built at cost of $1,850.00. Selling price, $2,500.00. The other is in good condition, $1,500.00. Humphrey-Stone-McColl Corp., Oil City, Penna., or phone E. M. White, Kittanning, Penna., 43-6177.

SPECIAL OFFERING TO END USERS

52,000'—9⅝" OD, H-40, P.E. 2100# test pipe. All new Limited Service. Can be used for Line Pipe or Surface Casing.

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24" GATE VALVES FOR SALE

From a Discontinued Project

11—New 24" 150# Cast Steel Flanged Gate Valves, Darling Mfg. Company #S42-DD.

$1630.00 ea.—F.O.B. Superior, Wisconsin

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WRECKING Two Major Oil Refineries

Pure Oil Ref., Charleston, W. Va., and Bay Ref., McPherson, Kans.

HOT OIL PUMPS—Simplex, Duplex, Centrifugal, 100 to 400 GPM, 100 to 1500 PSI—Steam, Electric Motor, Gas & Diesel Drives.
STEAM PUMPS Simplex & Duplex, 22 to 500 GPM, 100 to 1500 PSI.
FRACTIONATOR, 6'-6" x 58'-0", Shell ⅜", Heads ⅞", 40 Trays.
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STABILIZER, 3'-0" x 55'-0", Shell & Heads 9/16", Top Hd. Flgd.
NAPHTHA FLASH TOWER, 3'-0" x 37'-6", Shell & Heads ⅜", 7 Trays.
STABILIZER, 3'-0" x 49'-0", Shell & Heads 9/16", 30 Trays.
STABILIZER, 4'-0" x 48'-0", Shell & Heads ⅝", 30 Trays.
FRACTIONATOR, 3'-6" x 56', Shell & Heads ⅝", 22 Trays.
FLASH TOWER, 7'-6" x 32'-6", Shell & Heads ⅞", No Trays.
Other Towers & Pressure Vessels, various sizes & pressures.
Over 100 Heat Exchangers, Condensers, Reboilers & Coolers from 80 to 1500 sq. ft. capacity, Admiralty & Steel Tubes.
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Compressors, Gas & Steam Driven.
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Tank Plate 5/16"—¼" and ⅜"—large size sheets.
Used Pipe 2" to 10"—Excellent Condition.
Valves—Fittings—Used Structural Steel.

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ROY CRISP, Mgr., P. O. Box 2921, Charleston, W. Virginia.

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BIG SANDY, TEXAS

COMPLETE POLY UNIT, BUILT 1950
UOP RATED 144 BBL./DAY

Complete Perco unit built 1950, Phillips Petroleum rated 1400 bbl./day.
1—Wyatt 30" x 70' Stabilizer 160# 30 tray
30—Brown fintube exchangers, 600# 140 sq. ft. 4-6 chrome.
20—Brown fintube exchangers, 600# 11, 21, 77, 101, 140 sq. ft.
5—Adm. Heat Exchangers, 644, 424, 346, 176 sq. ft.
2—Perco reactors 4500 gal., 8' x 12', 347 stls. st. 120#, 1000° F.
1—5' x 96' tower, 40 tray, 135# WP.
1—7' x 30' Propane tank, 250# WP.
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1—6' x 34' Vacuum tower, 150#.
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3—Welded tanks, 10' x 40', 10' x 30', 5' x 20'.
3—St. Exchs., 920, 850, 480 sq. ft.
9—Oilfield boilers, 125 hp., 275#.
1—Ethyl lead plant.
3—Penn. comp. 8 x 11 x 9, 12 x 11½ x 13, 10 x 6 x 11.
2—Convection furnaces, 20 MIL BTU/hr.
1—Vapor phase cracking furnace.
12—**Welded storage tanks, 5000, 2000, 100, 500 Bbl.**
8—Hi-vol pumps, 10 x 7 x 18, 10 x 6 x 12, 6 x 4 x 12, 6 x 3 x 8.
30—Duplex piston pumps, all sizes.
1—10' x 30' asphalt still.
6—Steel Bldgs., 20 x 150, 12 x 20, 20 x 40, 20 x 20.
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1—BS&B Oil & gas separator, 10.7 mcf, 3500 Bbl./day.
Large Selection of Series 15, 30 Steel Valves, 1" to 8".
Approximately 15,000 ft. Schedule 40, 80 pipe, 2" to 8".

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2—Worth. LTC-6 830 hp Comps.
Gould 4" Pump 400 gpm 1600 hd
B-J hot oil pump 3 x 9, 13 st, 325 gpm, 4620' hd.
Gould 16" pump 10,500 gpm, 135' hd.
2 Worth. Pumps, 1500 gpm 50' hd.
1 BJ 8" Pump, 2000 gpm 115' hd.
1 BJ 2" Pump, 280 gpm 200' hd.

COLUMNS

7'6" x 55' 30 trays 45 lb.
8' x 75' 25 tray 40#
2' x 60' 35 tray 560#

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6—Adm. 785, 742, 425 sq. ft.
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30—Atmospheric Bentube exch., stls and Adm. 715, 470 sq. ft.
30—304 SS shell & tube condensers 100-1000 sq. ft.
Lab Petro-chem furnace 50,000 BTU/hr.

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2—10' x 40' hor wld. tanks
1—10' x 40' tank 30# WP
3—9' x 22' Vessels 165# WP
1—8½' x 22' hor tank

MISCELLANEOUS

800 ft. of 2" 4-6 ch pipe
Large quantity of 410 SS chrome strips and sheets.
Tremendous selection stainless steel and steel valves ½"-6".

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FOR SALE—1 National H-6 single crank pumping unit for 8000 ft. wells. SH-801 beam and post assembly, 72" stroke 40 h.p., peak torque 238,000 inch lbs. First Class Condition. Degen Pipe & Supply, Tulsa.

U-15 DRILLING RIG located in Beaver County. 3 NKU Waukesha Motors, Hydraulic Floor Operated Blowout Preventor, 131' Lee C. Moore Mast, steel mud pits, 7⅞ x 16 Gardner-Denver pump, 8000' 4½" Drill Pipe recomplete. Call CEntral 2-6318, Oklahoma City, Oklahoma.

FOR SALE—At Tallant Chemical Plant, 5—125 HP 250, and 300# WP, LFB boilers complete, $1500.00 each with burners and all attached equipment. See Mr. Mace at plant or contact Cities Service Oil, Patridge, Bartlesville, Oklahoma.

RECORDING INSTRUMENTS, fair condition, mounted on good truck. Dual power reels and cables. Bargain. Box J-460, The Oil and Gas Journal, Tulsa, Oklahoma.

MODEL S-50 Bethlehem Draw Works with JL 1335 Buda Engines. Excellent Condition. Located at Sapulpa, Okla. Phone 2089 or 464.

Fred E. Cooper Model "42"
THREE-DRUM SPUDDER

Complete with GKU Waukesha. Trailer Mounted with or without Tools. Less than year old. Any reasonable offer or terms considered. Contact

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For Sale—Equipment

Gas Booster Comp.—3 new 13" Worth. HB ea. connected to H-2000 Le Roi Eng. complete with scrubbers, aftercoolers, instruments, & safety equip. Will handle 2 million from 10 lb. to 800 lb. 3 stages—intermediate pres. 55 lb. & 225 lb. Ideal for gas lift—Customer out of gas—will sacrifice.

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2" & 2½" Alcoa Alum. Line Pipe in stock.

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very large lot of never used, first grade surplus oil drilling equipment consisting especially of Rock and Drag Bits (Reed, Hughes), Liner Hangers, Cementing equipment, slotted pipe casings API, threading and cutting machines, etc.

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1—800# 20 MMCF Absorber with Scrubber, etc.
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Vessels, Generators, Pumps, Instruments, Pipe, Valves, and Fittings and Other Equipment necessary in Gasoline Plant Construction. Detailed Inventory Available upon request.

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P. O. Box 670 Phone—EDison 2-8101
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FOR SALE: 86' Oilwell Mast, with 4½ Substructure. Telephone: CE 2-6318, Oklahoma City, Okla.

FOR SALE: 3—#71A Rebuilt Speedstars, also, can furnish 55 and 240 Speedstars, 21, 22, 24 Bucyrus and 33 Armstrong. Star Drilling Supply Co., Chanute, Kans., Phone 467.

GAS COMPRESSORS—3 Bessemer type 10 twins direct connected units—Boswell-Frates Company, 1003 Kennedy Building, Tulsa, Oklahoma.

FOR SALE—2 truck mounted Bettis steam units. Good condition, equipped for oil field work. Box J-332, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE—Two Walker-Neer Model C-34 Spudders. Trailer mounted. Waukesha 145GKU Engines complete with all drilling-in tools, doghouses, light plants. 7500 ft. ¾" drill lines, 7000 ft. ⅝" sand line. Inventory on request. Box J-473, The Oil and Gas Journal, Tulsa, Oklahoma.

CARDWELL "EC" Drawworks. Double drum with two D-13,000 Caterpillars compounded and pump drive. Drilled three—1000 foot wells since engines overhauled by Caterpillar. $15,000.00 cash or might sell on lease purchase. Darrell W. Smith, Phone 2-4336, Midland, Texas.

FAILING 1500, 42' mast, 28' x 3½" kelly, 180 International truck. Failing 750 Sullivan 37. Rred Butler, Box 481, Pueblo, Colo.

FOR SALE: National 50 Drilling Rig Complete, for details, call or write Ralph W. Shebester, Box 337, Pauls Valley, Oklahoma. Telephone 570.

COMPRESSOR BUILDING — Structural steel, 12' x 35' x 12'. Boswell-Frates Company, 1003 Kennedy Building, Tulsa, Oklahoma.

UNUSED ARMY EQUIPMENT Cable Tool Rope Sockets, tool joints, wrenches, perforators, 3" joints. Spare parts Marmon Harrington all wheel drive 42 Fords—transmission XSM2631 and 2341 for Geo. E. Failing machines. Briggs Oil Clarifiers. Oil transfer pumps. Many sizes V-belts, repair parts various generating sets. Write J. B. Reed, Fredericktown, Ohio.

FOR SALE: 1—Oil Well DGE Model 300, Waukesha RLZ motor, Chicago Pneumatic Compressor with 2 cylinders 5 x 13, single stages, testing 1000# unit package—4 Knight Units, with Waukesha engine WAKB, 225 h.p. Worthington compressor 5¼ x 13, with sleeve 6 x 13—1 Homco Unit, Waukesha engine 6WAK, Worthington compressor 5¼ x 13. Complete with scrubbers, automatic dump traps, pressure shut down switches on portable skids. Box J-481, The Oil and Gas Journal, Tulsa, Oklahoma.

EQUIPMENT WANTED

WANTED—Used Pipe Threading and Cutting Machine—Capacity either 2½ to 6" or 4 to 8"—Direct Motor Drive—Landis make preferred. Advise price and location where same can be inspected. Box J-456 The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED

INGERSOLL-RAND KVG

COMPRESSOR CYLINDERS

SIZES 12" x 14"

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C. E. Starrett

BOX 633

REFUGIO, TEXAS

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MORE LOGS ARE FILED in Kraftbilt Strip Log Cabinets than all others combined. Loaded drawers glide smoothly on roller bearings. Three drawers per section, add sections as needed. Built to last a lifetime! Send for new Catalog 1156-B. Ross-Martin Co., P. O. Box 809-A, Tulsa 1, Okla.

HELP WANTED

FOREIGN EMPLOYMENT. List of oil companies and drilling contractors showing where to apply for foreign jobs. OIML Co., Box 2803, Tulsa, Okla. $5.00 cash.

PROCESS ENGINEER—Experienced Engineers for process design with well established manufacturer. Mid-Continent area. Challenging work with excellent opportunity for advancement. Salary commensurate with experience. Relocate. All replies will be kept in strictest confidence. Box J-461, The Oil and Gas Journal, Tulsa, Oklahoma.

Plant Equipment Inspectors

Graduate engineers with minimum 5 years' experience in design or inspection of petroleum processing plants and equipment. Major part of experience must have been in inspection work entailing general knowledge of all facilities. Develop inspection methods, supervise and conduct inspections and advise operations on codes and equipment limitations in a major oil installation located in Saudi Arabia.

Write giving full particulars regarding personal history and work experience. Please include your telephone number.

Recruiting Supervisor, Box 90

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For drilling production and equipment on varied types active fields.

EXCELLENT SALARY, ALLOWANCES, OPPORTUNITY OBTAIN ADDITIONAL EXPERIENCE & ADVANCEMENT.

Positions Available Venezuela & Colombia. Graduate Engineers—minimum 2 years exp.

Forward Personal data, college transcript, to:

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26 Broadway, New York 4, New York

HELP WANTED

EXPERIENCED NATURAL GAS engineers or petroleum engineers with natural gas experience needed by oil company with expanding gas operations. Minimum of 4 years necessary. Applicants should submit resume of education, experience and state salary expected. All applications treated confidentially. Box J-385, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGISTS—Two to four years experience for work in Gulf Coast Area. Salary commensurate with experience. Replies confidential. Lion Oil Company, a Division of Monsanto Chemical Company, P. O. Box 1607 Shreveport, Louisiana.

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You can fill a desirable **permanent** position in McKee's enlarged Refinery, Metals or Industrial Divisions. Our expansion program gives you excellent opportunity for advancement in one of the world's largest engineering firms.

World-wide McKee operation offers you wide choice in the design of Petroleum Refineries, Chemical Plants, Blast Furnaces, Steel Plants, Sintering Plants and Industrial Plants in the following fields:

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Cleveland 1, Ohio

HELP WANTED

GEOLOGISTS—Two to three years subsurface experience in Midcontinent or Rockies needed by consulting firm. Apply by letter giving qualifications and salary. Box J-463, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED—URANIUM GEOLOGIST with background of exploration and evaluation experience by major oil company. Send complete resume of education, experience, and salary requirement to Box J-447, The Oil and Gas Journal, Tulsa, Oklahoma.

DIVISION MANAGER FOR CONTRACT SEISMIC OPERATION

A top level position for a fully qualified man. Must have experience in **West Texas and New Mexico.**

Based in Midland. Furnish references and resume of experience and background.

Box J-457, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEERS

Active independent oil company has vacancies for graduate petroleum engineers with two to five years of practical experience in drilling and production in West, West Central or North Texas. Excellent opportunities for growth and advancement. Replies should furnish complete personal data, education, experience, and starting salary desired.

BOX J-300,
THE OIL AND GAS JOURNAL,
TULSA, OKLAHOMA.

Unusual Opportunity for Petroleum Engineer

AAAI Texas manufacturing company is looking for man 28 to 40 years of age to become manager of division servicing refineries. We manufacture chemicals used in cleaning towers, heat exchangers, and other refinery units. Man selected must be ambitious and have sales personality. Write letter giving complete background and experience. All inquiries confidential. Write

Box J-459,
The Oil and Gas Journal,
Tulsa, Oklahoma

PETROLEUM ENGINEERS

Experienced graduate engineers for immediate openings in Saudi Arabia and New York City. For engineering work in development, production, drilling, process, and oil and gas engineering on primary and secondary recovery problems.

RESERVOIR FLUID ANALYST

With degree in Physical Chemistry or Chemical Engineering plus 5 years' petroleum production engineering experience which should include 2 years' study of reservoir fluid behavior.

Salaries commensurate with training and experience. Write outlining personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 116

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505 PARK AVENUE

SOHIO PETROLEUM COMPANY

has positions open for

JUNIOR GEOPHYSICISTS and COMPUTERS: B.S. or M.S. Degrees in Geology, Mathematics, Physics, Geophysics or Electrical Engineering, to enter Exploration Trainee Program.

SENIOR GEOPHYSICISTS: Similar academic background with at least 10 years' experience in field work and geophysical interpretations or geophysical research.

Salary commensurate with training and experience. Outstanding benefit programs. Unusual opportunities for well-qualified men. Give full particulars regarding education, experience, salary requirements and photograph. Replies held in strictest confidence.

C. O. Krueger
Sohio Petroleum Company
1615 First National Building — Oklahoma City 2, Oklahoma

HELP WANTED

$ SALES REPS. WANTED

For Complete Line of Telemetering, Control and Telegraph Terminals

We seek a few experienced sales engineering reps. to serve customers & call on prospects in Northwest, Southwest & South.

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BOONTON, NEW JERSEY

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For reservoir studies, reserve estimation & development work on varied types active fields.

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Positions Available Venezuela & Colombia. Graduate Engineers—minimum 3 years exp.

Forward personal data, college transcripts, to:

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26 Broadway, New York 4, New York

Petroleum chemist

BEEN LOOKING for a position with lots of day-to-day variety and interest? The petroleum instrumentation section of the Fisher Development Laboratories is the place. Your assignment: to design and promote new items in a leading line of petroleum testing equipment and handle liaison with the ASTM.

Age: 30-40 . . . petroleum lab experience . . . familiarity with ASTM methods and apparatus . . . a flair for instrument design. Employee benefits are excellent; working conditions A-1.

Rush résumé (confidential), salary requirements, instrumentation background, to PAUL FAUPEL, PERSONNEL MGR., FISHER SCIENTIFIC, 711 FORBES ST., PITTSBURGH 19, PENNA.

HELP WANTED

GEOLOGIST—Desire to employ competent and experienced geologist with executive ability to head and direct large exploration program of independent oil and gas producer. Requirements: Minimum of 10 years' experience in oil exploration with a portion of it on the Gulf Coast. Age, 32 to 45. All replies will be kept confidential. Box J-477, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED—Responsible Operator to properly complete a test through the Knox Dolomite, on a structural high in Kentucky. Three previous tests had very good shows in this formation. No promoters or brokers. Box 2, Clarendon, Penna.

SALES ENGINEER (New Product)

Graduate petroleum, mechanical or chemical engineer with petroleum experience needed for interesting assignment to assist in development and promotion of new equipment for use in petro-chemical industry. Should be familiar with oil processing equipment, design and application. Work will include personal contact with major oil companies. Sales experience helpful.

Mail brief description of qualifications to:

DORR-OLIVER INCORPORATED
2900 Glascock St.
Oakland 1, California.

Petroleum Geologists

Established Oil Company desires geologists for employment in West Texas area. Must know area and have four to six years of active experience in subsurface mapping and interpretation. Excellent opportunity for advancement. Salary will be commensurate with ability and experience. Reply should state age, education, experience, and salary desired.

BOX J-485,
THE OIL AND GAS JOURNAL,
TULSA, OKLAHOMA.

AREA ENGINEERS

Several graduate engineers with minimum 5 years' experience supervising maintenance engineering functions in oil refining or producing facilities, power plants, heavy industrial installations, manufacturing plants or related operations. To establish technical supervision, procedures, maintenance operations and schedule routine and special work for major oil producing and refining operation with all supporting facilities; i.e., housing, feeding, recreation, etc.

Salary commensurate with background and experience. Write giving full particulars regarding personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 64

ARABIAN AMERICAN OIL COMPANY
505 PARK AVENUE
NEW YORK 22, NEW YORK

PETROLEUM ENGINEERS

Graduate Petroleum Engineers with 2 - 6 years' experience wanted by Major Oil Company for work in Mid-Continent and Gulf Coast areas. Openings available for Reservoir and Field Production Engineers. In first reply give resumé of experience, date available, and salary expected.

BOX J-479, THE OIL AND GAS JOURNAL, TULSA, OKLAHOMA.

HELP WANTED

EXPERIENCED EMPLOYEES, for all positions on seismograph field crews, wanted by aggressive, expanding geophysical company. Please give full details of education, experience, salary expected, in first letter. Box J-455, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEERING GRADUATE

Preferably with some oil field experience in the Southwest who may be interested in reservoir study, pressure maintenance, water flooding, gas repressuring, field supervision, core analysis, and appraisal work in conjunction with our small well established consulting petroleum engineering firm in North Texas. Adequate compensation with advancement. Include personal data, snap shot, oil field experience, scholastic standing, when available, marital status, draft or service prospect, etc. in your letter to:

BOX J-486,
THE OIL AND GAS JOURNAL,
TULSA, OKLAHOMA.

OIL FIELD SERVICE ENGINEERS

Mechanical or Petroleum Engineers with some field experience. Men without degrees but with two years rotary or workover rig experience may qualify. High school diploma or equivalent required. Age under 35 preferred. Good pay with excellent fringe benefits. Automobile and expenses.

Contact

BAKER OIL TOOLS, INC.
P. O. Box 3048
HOUSTON 1, TEXAS

MATERIALS PERSONNEL

MAJOR INTERNATIONAL OIL COMPANY has following vacancies at salaries commensurate with qualifications and experience for candidates to 45 years of age:

MATERIALS SUPERVISOR
New York City

- 10-15 years oil drilling and production materials processing, including 5-8 years foreign service and several years high-level administration experience.
- Detailed knowledge of coding gained either in setting up materials and equipment code or experience with integrated oil materials code system.

ASST. MATERIALS SUPERINTENDENT
Far East

- 15 years experience covering all phases materials activities, including minimum 8 years foreign service.
- Modern methods stock control and ordering experience.
- High-level administrative experience essential.

Send detailed resume to:

BOX NO. J-471
The Oil and Gas Journal,
Tulsa, Oklahoma.

HELP WANTED

EXPERIENCED Petroleum Engineers to fill vacancies created by expansion wanted by medium sized oil company operating in all areas east of California. Applicants should have minimum of 3 years field experience. Replies confidential. Please furnish detailed summary of academic and experience background. Box J-377, The Oil and Gas Journal, Tulsa, Oklahoma.

CHEMICAL ENGINEERS

For responsible staff positions in New York Office directing the work of groups of experienced engineers doing process evaluation and design, economic studies and related work on refining and crude oil handling facilities, together with supporting power plants and other utilities. Work entails occasional trips of short duration to Europe and Middle East. Chemical Engineering degree plus 5 years' process experience, preferably in petroleum.

Salary commensurate with training and work experience. Liberal benefit program. Write giving full particulars regarding personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 100

ARABIAN AMERICAN OIL COMPANY

505 Park Ave., New York 22, N. Y.

SITUATIONS WANTED

GRADUATE PETROLEUM Engineer desires position with independent oil company. Eight years experience with major company, principally in field operations. Last four years as production supervisor of large area. Box J-474, The Oil and Gas Journal, Tulsa, Oklahoma.

EXPLORATION SUPERVISOR—Graduate geologist and business management. Fourteen years domestic and foreign experience geological, land and administration. Now employed in middle management position. Desires connection with aggressive company in administrative or exploratory capacity. Box J-478, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST, 32, 6½ years diversified Oklahoma subsurface experience with major company, including 3½ years Southern Oklahoma, desires position with independent or small company. Currently employed. Complete resume on request. Box J-467, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER with 18 years of drilling, oil, distillate and gas well experience. Field and administrative. Handled district organization and petroleum engineering department for major. Desire change to manage independent's operations. Excellent references. Reply Box J-468, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER now in supervisory position as Area Engineer over large, active major company area wants job having equal or greater responsibility with independent. 29, married, graduate, 6 years West and West Central Texas experience. Outstanding promotion record based on ability all phases production and drilling. Box J-438, The Oil and Gas Journal, Tulsa, Oklahoma.

LANDMAN available immediately. Now in Denver. 8 years experience in Permian and Denver Basins. Will relocate. Box J-466, The Oil and Gas Journal, Tulsa, Oklahoma.

PRODUCING MANAGER

TOP LEVEL graduate engineer seeks a position with a sound aggressive independent requiring a man with solid administrative and practical background and knowhow in drilling, producing and cost engineering; both domestic and foreign. Well experienced in program planning and budget analysis. Excellent character and business references covering years of diversified experience. Age 38. Reply

Box J-469, The Oil and Gas Journal, Tulsa, Oklahoma.

SITUATIONS WANTED

REFINERY ENGINEER, M.S. Degree. Fourteen years diversified experience in Refining and Natural Gasoline field. Desire responsible position in operations, project engineering or sales. Box J-462, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOPHYSICIST-GEOLOGIST—15 years experience, 5 years supervisory capacity. Desires position with independent or small oil company. Reply Box J-480, The Oil and Gas Journal, Tulsa, Oklahoma.

PRODUCTION SUPERVISOR—10 years' experience in drilling and production, 5 years in supervisory capacity. Experience in Mid-Continent, Gulf Coast, and Rocky Mountain. Graduate engineer, 38, married. Presently employed. Desire to locate in Rocky Mountain area with independent or small integrated company. Box J-482, The Oil and Gas Journal, Tulsa, Oklahoma.

ROYALTIES

HIGHEST PRICES PAID for choice oil and gas income royalties, overrides, oil properties. A. S. Berry, P. O. Box 1383, Tulsa, Oklahoma.

OFFERING CHOICE PRODUCING oil and gas income royalties with large reserves per Dollar investments. A. S. Berry, P. O. Box 1383, Tulsa, Okla.

MINERALS AND ROYALTIES in choice properties in Texas. Under lease and committed for drilling soon. Priced reasonably. Write or wire for details. Box J-484, The Oil and Gas Journal, Tulsa, Oklahoma.

BUSINESS SERVICE

Delaware Corporations formed and serviced. American Guaranty & Trust Company, P. O. Box 487, Wilmington, Delaware.

WANTED

5 TO 500 WELLS WANTED. Serious buyer seeks willing sellers with expert reports. Quick action. Strictest confidence. Box J-423, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED

TO PURCHASE oil production or corporations having production for cash or stock in a listed company (or combination of both). All replies strictly confidential. Box J-412, The Oil and Gas Journal, Tulsa, Oklahoma.

MAILING LISTS

MAILING LISTS—Covering all branches oil industry. Free catalogue. Oil Industry Mailing List Co., 405 Tuloma Bldg., Tulsa, Okla.

BUSINESS OPPORTUNITIES

Would trade Phillips 66 bulk station on jobber contract wiih cafe and grocery attached (living quarters on same lot). Situated in small county-seat town—has been under same mgt. since 1938. Large trade area. All for fully equipped 45 100' rotary rig in good condition. Contact Wycoff Brothers Oil Company, Oakley, Kansas. Tele. ORange 2-3271.

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